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Nocturnal Flights of TRIATOMA (Hemiptera: Reduviidae) in Sabino Canyon, Arizona

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NOCTURNAL FLIGHTS OF TRIATOMA (HEMIPTERA:REDUVIIDAE) IN SABINO CANYON, ARIZONA

by

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Each person whose signature appears below certifies that this dissertation in his opinion is adequate, in scope and quality, as a dissertation for the degree Doctor of Philosophy.

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Dedicated to my father and mother

Mr. and Mrs. Ralph Ekkens

and to my wife Sharon

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INTRODUCTION

Triatoma rubida uhleri (Neiva) (Hemiptera: Reduviidae: Triatominae) is the most common Triatominae in southern Arizona (Wehrle, 1939). In North America the Triatominae (conenose or kissing bugs) are blood-sucking ectoparasites on mammals, primarily wood rats of the genus *Neotoma*. They live in the nesting material of wood rat lodges; at times they enter homes and bite people, causing an allergic reaction in sensitized individuals.

In Central and South America several species of Triatominae enter homes regularly and serve as the vectors of *Trypanosoma cruzi* Chagas, the etiological agent of Chagas' disease. This debilitating disease, sometimes called American Trypanosomiasis, affects 7 million people in Latin America. The hosts of the Triatominae in Latin America include many species of mammals and birds.

Because there is no known cure for Chagas' disease, preventive measures seem to offer the most hope of controlling the disease. This project is an attempt to answer a number of questions concerning the flights of *Triatoma* spp. in southern Arizona; i.e., cause of flight, time of day and season of the year most of the specimens fly, effect of various physical factors (air temperature, relative humidity, wind speed and direction) on flights, and distance flown. Answers to some of these questions might prove useful to residents of rural areas in southern Arizona where Triatoma spp. are a minor health problem.

Several authors have mentioned that conenose bugs are attracted to lights (Wehrle, 1939; Sjogren & Ryckman, 1966). Most flying is usually reported to occur after dark, although Usinger (1944) reported a flight of T. rubida uhleri in the daytime at Peach Springs, Arizona in June, 1930.

Francisco Campos (1931) suggests that Triatoma dimidiata (Latreille) became established in Guayaquil, Ecuador, after electric lights became common early in this century. Mazzotti (1940) also mentions the attraction of T. dimidiata to lights in Mexico. Gomez-Nunez (1969) suggests that flight is one factor in the spread of Rhodnius prolixus Stal in Venezuela. Flight is certainly not the only means of movement; Zeledon et al. (1973) suggested that nymphs of T. dimidiata may move more easily than adults do.

MATERIALS AND METHODS

Study Area

Location and Description

The field portion of this study was conducted at lights in Sabino Canyon in the Coronado National Forest northeast of Tucson, Arizona. Sabino Canyon runs northeast (FIG. 1) and cuts into the southern slopes of the Santa Catalina Mountains 21 km northeast of Tucson. Sabino Creek begins on 2820 m Mt. Lemmon, the highest peak of the Santa Catalinas, and flows 24 km to the mouth of the canyon. There is water in the creek throughout most of the year except in June. The precipitation which feeds the stream falls as winter snow at the higher elevations and summer rains.

A road extends 4.8 km from the park boundary up the canyon, paralleling the stream. Another road runs east into Bear Canyon, which roughly parallels Sabino Canyon. The elevation varies from 838 m at the Visitor Center to 1036 m at the end of the Sabino Canyon road. The elevation is 850 m at the main collecting site.

Light Traps

On the map (FIG. 1) the locations of lights, instrument shelter and other significant points are indicated. The location of the main light was on a black-topped driveway near a stone house (referred to as

"Old House"). The black-topped driveway offered a smooth surface free of debris which facilitated the collection of insects. Near the light is a dry wash leading to Breakfast, Rattlesnake and Bird Canyons and referred to as Breakfast Canyon. Three Stikem traps were set up in this canyon in 1972 and 1 in 1973. FIG. 2 is a view of the collecting site looking to the west up Breakfast Canyon.

During the 1972 season Triatominae populations were also sampled near the park entrance station over a water bath trap similar to that used by Sjogren and Ryckman (1966) except that a plastic-lined depression was used as a water bath. This trap caught only 1 or 2 Triatominae per night. When the electricity was turned off at the entrance station, the light was moved to private land just below Sabino Canyon; and the water bath was replaced with a plastic funnel 76.2 cm in diameter. This caught a few bugs, but it was late in the summer and few bugs were flying. These traps were not used during 1973 due to the low number of bugs caught in 1972.

Light traps were operated 4 to 6 nights per week from 19 June to 24 October 1972 (87 nights) and from 6 April to 4 August 1973 (57 nights). In addition to this, 4 trips were made to southern Arizona during the 1972-1973 fall and winter on 24, 25 November; 17, 18 December; 3, 4 February; and 2, 3, 4 March. The purpose of these trips was to examine rat nests to determine if there were any adult bugs and to check on night temperatures. On 4 February 1973, the black light was operated for ca. 1 hour. The temperature was 15°C, and there were very few insects of any species flying.

Rainfall

As part of the Sonoran desert, Sabino Canyon depends largely on summer rains for precipitation. Mr. Ormsby (personal communication, 1973) has recorded a 29-year average of 30.2 cm of rain per year (TABLE 1), of which 38.2% fell in July and August. The total rainfall for 1971 was 43.9 cm and for 1972, 43 cm. The first 6 months of 1973 totaled 16.49 cm of rain as compared to a 29-year average total of 8.79 cm for those months. TABLE 1 shows that the late winter and spring seasons of 1972 were drier, but that the summer and fall were wetter than average. During February, March and July of 1973 the rainfall was much greater than normal.

Habitat

The habitat of the study area is a creosote bush-cactus community of the Arizona desert (Benson 1957) occuring in the Lower Sonoran Life Zone (Merriam 1898). The creosote bush, Larrea divaricata Cav. (Zygophyllaceae) is a characteristic dominant shrub of the Arizona desert, and the dominant cactus is Carnegiea gigantea (Engelm.) Britt. & Rose (Cactaceae), the well-known saguaro.

Some of the cacti of this community which are important to the wood rats for food, protection and/or nesting materials are *Ferocactus wislizenii* (Engelm.) Britt. & Rose, *Opuntia bigelovii* Engelm., *O. phaeacantha* Engelm. and *O. versicolor* Engelm.

Several of the legume shrubs (Fabaceae), which are also important food plants for wood rats, are *Acacia greggii* Gray, *Cercidium floridum* Benth., *C. microphyllum* (Torr.) Rose & Johnson and *Prosopis juliflora* (Sw.) DC.

Wood rat lodges are often constructed at the base of buckthorn shrubs, *Condalia lycoides* (Gray) Weberb. var. *canescens* (Gray) Trel. (Rhananaceae). Leaves of the creosote bush are sometimes found in the lodges of wood rats.

Plant determinations were made using field and herbarium specimens. Current nomenclature was used according to Munz & Keck, (1968) and Kearney & Peebles (1960).

Equipment

Lights

The light consisted of two 46 cm fluorescent black light tubes in fixtures mounted back to back. These were hung in front of a 1.2 x 1.2 m piece of white pegboard, giving a reflective surface for insects to fly against. The holes in the board allowed the light to be seen for some distance up Breakfast Canyon (See map, FIG. 3). In 1973 a large hole was cut in the pegboard and covered with clear plexiglass which allowed the light to be clearly seen from Breakfast Canyon.

During the summer of 1972 the light was powered by a Sears 1100 watt gasoline generator and by a TravElectric portable power supply (Taredo Corp., Model 50-160). The portable power supply contained a vibrator which failed to operate several times during the summer of 1972. A more satisfactory light system was used in 1973. Two 12 volt fluorescent light fixtures (Lo-Volt Inc., Compton, California) were bolted back to back. These use the same black light tubes as the 110 volt fixtures but run off a 12 volt battery. They were powered by the small 12 volt battery of the TravElectric power supply, which was charged from house current during the day from the built-in charger. A car battery was used as a supplementary power source and could operate the light for 5 to 6 hr without apparent power failure.

Other Equipment

A hygrothermograph (Model 594, Bendix Corp., Serial No. 10756) was mounted on a rock wall beside the driveway every night. This was set on a daily cycle and recorded temperature and relative humidity (RH) data. The RH reading was calibrated using a sling psychrometer and conversion calculator.

Seven-day records of temperature and relative humidity were obtained on another hygrothermograph (Belfort Corp., Model 594, Serial No. 2106) situated near the Lowell Ranger Station 1 km down canyon from the light. The hygrothermograph was run continuously from 28 June 1972 to 6 August 1973. During the winter it was maintained by Robert Barnacastle of the Sabino Canyon Visitor's Center.

Because Sabino Canyon is near Tucson and has water running in its stream most of the year, the area has heavy visitor use (600,000 visitors per year). Consequently, vandalism is quite a problem if equipment is left unattended during the day. It was therefore necessary to take all equipment home each night after work. At Lowell, equipment was safe, and nothing was molested. The hygrothermograph was housed in a standard weather instrument shelter.

To determine accurately the light intensity, a light meter calibrated in footcandles, was used (Model 4 268 WA 620, Serial No. 9226, Kahl Scientific Instrument Corp.). The light-sensitive cell was held up and pointed toward the lightest part of the western horizon. Light readings were usually begun 10 to 15 min. before the zero footcandle level was anticipated, and readings were taken every 3 or 4 min. until the zero footcandle level was reached. It was found that on a clear evening the zero footcandle reading was obtained ca. 40 min. after the official time of sunset.

Because the collecting station is in Sabino Canyon, the official times of sunset and moon rise and set do not correspond to conditions in the canyon. In my data logs the time the moon could actually be seen rising above the surrounding hills was indicated. Official moonrise is earlier and moonset later than indicated in my log, and the same is also true for the sun.

Rain records were obtained from Mr. Ray Roser, caretaker of Sabino Canyon. Weather information was also obtained from Mr. Walter Ormsby, who maintains the Sabino Canyon weather station for the U. S. Weather Service (See Map, FIG. 1).

One instrument which proved very useful was the tempscribe (Model 55B, Bacharach Co.). This is a small, temperature-recording device that operates on a weekly cycle and is small enough to be placed in a wood rat lodge without disturbing the animal.

Stikem Traps

The Stikem traps consisted of sheets of 63.5 mm (1/4") mesh hardware cloth coated with a layer of Stikem Special (Michel and Pelton Co., Emeryville, Calif.). Two traps were mounted on poles, and a third was hung from a nylon rope stretched 45 m across the canyon at right angles to the long axis of Breakfast Canyon. One trap (61 x 122 cm) was mounted on 2 poles. The bottom of this trap was 1.8 m from the ground. A second trap was 1.2 x 1.2 m, and the lower edge was 3 m from the ground. The third trap was 2.4 x 2.4 m and was 4.5 m above the canyon floor. This device wasn't put up until 8 August 1972 and was the only trap put up during 1973.

Collection at Lights

Procedure at Light

The collecting light was turned on soon after sundown. Very few insects of any species came before dark. In 1973 the light was operated all night on 14 nights, during which time I stayed up searching for bugs.

In the Old House collecting area the driveway was marked off in 1-foot units to form a grid. When *Triatoma* landed on the driveway, their location was recorded on a daily work sheet along with the time of arrival, sex and pertinent weather information. Each bug was placed in a 70 x 20 mm glass vial fitted with a cork stopper and containing a piece of filter paper which provided a substrate for the bug to climb on and a surface to absorb fecal moisture. Each glass vial was numbered; these numbers corresponded to numbers on the prepared daily work sheets so that the first bug to be collected on a given evening was placed in vial #1, and the information for that specimen was written opposite #1 on the work sheet. Weather information included air temperature, relative humidity readings, moon size, sky conditions, and wind speed and direction. Wind speed readings were taken with a hand-held

Bacharach (style 3035A) wind gauge; a wind vane indicated direction.

Weighing and Marking

The bugs were taken home each night after collection. They were kept in the glass vials until the next day when they were measured, marked and weighed, usually within 12 hr of collection. After marking and weighing they were placed in larger plastic vials with gauze tops, 4 or 5 bugs per vial. The numbered glass vials were reused the next night.

The bugs were weighed to the nearest 0.1 mg on a Mettler balance (Type H6). Measurements were obtained with a caliper to the nearest 1/64"(0.39 mm); specimens were measured from the posterior tip of the abdomen to the anterior tip of the clypeus.

The thorax was marked by a combination of paint dots. There are 7 positions where a paint dot can be applied. These positions have the numerical values 1, 2, 4, 8, 16, 32, and 64. By using various combinations of dots, all the numbers from 1 to 127 can be obtained. To add more numbers colors can be changed. Number 1 to 127 were red, 201 to 327 were blue, etc. By mixing 2 colors a very large number of bugs can be marked.

The paint used was Testor Model paint and "Pactra namel", both of which are obtainable in bright colors and are fast drying. Preliminary tests on Triatoma lecticularius (Stal) indicated that the paint dots remained on for long periods of time (3 months), and if removed forcibly (with a scalpel) left flecks of paint so that one could see that there had been a dot there. Nail polish was not usable because the whole dot could be removed with the aid of a scalpel.

When the bugs were weighed, they were all examined for general state of nutrition and presence of ectoparasitic mites; and the vials were checked for eggs the female bugs may have laid.

Eleven females and 14 males of _T. rubida_ (flight-starved bugs) were retained separately in plastic vials in a _Neotoma_ lodge after capture at the light. They were weighed at capture and at death. Forty-six females (egg layers) were fed weekly after collection at the light and retained without males present in a _Neotoma_ lodge to determine fertility and fecundity of flying females.

Analysis of Data

The data concerning _T. rubida uhleri_ collections (and _T. recurva_ (Stal) for 1973) and physical conditions was punched on computer cards; programs in FORTRAN IV were written to analyze the importance of the various physical factors. Data for _T. recurva_ collected in 1972 and _T. protracta_ (Uhler) for 1972 and 1973 were not used due to low numbers collected (TABLE 2).

In order to examine all physical factors, analysis of the data was made using a computer program (BMD 02R) from UCLA Health Sciences

Computing Facility and available through the Data Processing Center of Loma Linda University. This program is a step-wise regression analysis. It takes into account the effect of the moonlight, wind speed, air temperature, cloud cover, relative humidity and time of day on the number of bugs. It not only shows which physical factor or factors are most highly correlated with number of bugs, but also which physical factors are correlated with other ones.

To obtain mean night temperature and relative humidity, readings were taken every 20 min. and averaged.

Mark-Release-Recapture Studies

Release Methods

In an attempt to discover from what direction and how far the bugs fly, mark-release-recapture studies were carried out. In 1972, 402 adult bugs (371 *T. rubida* and 31 *T. recurva*) were marked and released, and in 1973, 322 *T. rubida* and 129 *T. recurva* were released.

Bugs were released during peak flight periods. At first, releases were made early in the evening, before dark, with very few recaptures. Then one night bugs were not released until after dark. That night there were 3 recaptures; from then on most releases were made after dark.

Most bugs were released from plastic vials directly onto a rock.

They usually crawled over the edge of the rock to escape the light of my flashlight. The light was shut off as soon as possible after the release.

In August 1972, a release box was made which allowed release of the bugs without disturbing them unnecessarily. This was a flat board with an opaque plastic cup inverted over it. The bugs were passed through a small door in the side of the cup and placed on the board. After they became quiet, the cup was lifted off gently by a string, leaving the bugs exposed on the flat board. On several occasions *T. rubida* were observed with a red light. Some moved off very rapidly, and some remained on the board for 15 min.

Release Sites

In 1972 there were 6 main release points (FIG. 3). Four of these were located up the main canyon from the light: "One Way", "Road Y", "Mesquite" and "Km 0.4". All of these were within line of sight of the light, but an insect would have to rise at least a meter above the ground to see the light. The same is true for the other 2 release points "Breakfast", up Breakfast Canyon and "Down", located 55 m down canyon from the light.

In 1973, 6 release points were used, all located farther from the light than those used in 1972. "Flood Gate" was 0.5 km up canyon; "Km 0.8" and "Km 1.6" were also up canyon. Down canyon there were

3 release sites: "River Trail" (0.4 km), "Pump House Trail" (0.8 km), and "Lower Sabino Trail" (located near the stream). All of these release sites were out of sight of the light. A bug leaving from these sites would have to fly toward the light at least 100 m before being able to see it.

Studies of *Neotoma* Lodges

Location of *Neotoma* Lodges

From 23 July 1972 to 3 August 1973, 79 lodges of *Neotoma albigula* were examined, and most of these lodges were in Bear Canyon ca. 2 km east of Sabino Canyon (FIG. 1). Nests outside of Sabino Canyon were selected for 2 reasons: 1. Continued collection of specimens in Sabino Canyon may subsequently alter the flight activity in this main flight study area, 2. The lodges are in the same type of habitat as Sabino Canyon.

One nest was examined 3.2 km southwest of the entrance to Sabino Canyon Recreation Area along the Sabino Canyon road. West of Sabino Canyon (2 and 4.5 km respectively) are 2 canyons, Esperero and Ventana. The lower part of these canyons are on private property, and the residents gave permission to examine wood rat lodges on their land. Nine lodges were opened in Esperero and 13 in Ventana.

Description of Lodges

In the area where this research was conducted, Neotoma albigula albigula Hartley is the most prevalent wood rat. This wood rat constructs large lodges under the massive rocks that form the walls of the canyon. Weathering has broken off pieces of metamorphic rock 1 to 3 m in diameter and 0.3 to 1.2 m thick. The wood rats prefer to build their lodges under and behind these rocks. If no rocks are available, the wood rats build lodges at the base of a shrub. The most abundant and conspicuous material in the nests are joints of the teddy bear or jumping cholla, Opuntia bigelovii. FIG. 4 shows a typical N. albigula lodge in Bear Canyon.

In the interior portions of the lodge the nesting material is composed of sticks, leaves, cactus pads (Opuntia Engelmanii and O. versicolor), remains of cactus fruits (O. Engelmanii, Carnegiea gigantea and Ferocactus Wislizenii) and various miscellaneous objects such as bottle caps, animal bones, pieces of charcoal, empty rifle shells, palo verde beans and green leaves. In several lodges desert tortoises were found, as well as a banded gecko, hibernating bats, scorpions and many species of insects.

Procedure of Examining Lodges

Because Neotoma albigula lodges are usually under rocks, 2 useful tools in examining lodges were a pick and a crowbar. These were used to pry the rocks off in order to pull the nesting material out. The nesting material and all rocks were examined for bugs. Triatoma bugs often remain still and are difficult to see in the nesting material or in cracks in the rocks. When the nesting material is pulled out into the sunlight, the Triatoma usually move soon.

It was found that very small nymphs (1st and 2nd instars) were difficult to pick up so a small bowl or dish was used to help isolate the bugs from the nesting material. When a small nymph was discovered, it was put with the dirt and nearby debris into the small bowl. Then the nymph could be picked out of the bowl.

Field and Laboratory Culture of Triatoma

Many of the bugs from the Neotoma nests were kept alive to discover when 5th instar nymphs become adults. The first bugs kept alive were collected 30 August 1972. These were placed in plastic vials (24 x 60 mm) with plastic snap tops. The center of each top was cut out, and a piece of gauze was placed over the top of the vial before the top was put on. This allowed the bugs to get air and also to feed through the gauze top.

The vials were placed in screen cages wired to the tempscribe and placed in a Neotoma albigula lodge in Bear Canyon. The screen cages were made from 32 mm mesh hardware cloth. This lodge was under an overhanging rock and had a flat rock over the opening. The crevice under the rock overhang was 15 cm high, so the wire cages could be slid into the nest without disturbing the nest too much. FIG. 5 shows the tempscribe in the lodge, and the insects are concealed below it.

The tempscribe was placed in this nest on 30 July 1972, and the first nymphs were placed in the nest on 31 August. The tempscribe remained in the _Neotoma_ lodge until 5 August 1973. From 30 July 1972 to 13 November 1972 and from 6 April 1973 to 5 August 1973 continuous records of this _Neotoma_ lodge temperatures are available. Each time I went over to Sabino Canyon during the winter, I wound the tempscribe so that 4 periods of 10-13 days of records were obtained during the winter.

The lodge was evidently inhabited by a wood rat for most of the time the tempscribe and bugs were in it. Often when the nest was opened it was necessary to remove some cholla joints that the wood rat had piled on the tempscribe. As far as it was possible to determine, the wood rat never tried to gnaw into the wire cages.

The bugs were taken out of the nest and fed weekly on round-tailed ground squirrels (_Spermophilus tericandatus_) or white-throated wood rats (_N. albigula_).

Nymphs obtained from _Neotoma_ lodges were divided into 2 main groups. One group was maintained in an incubator at 26.7°C in the laboratory. The other group was retained in the *Neotoma* lodge as described above. After 4 April 1973, the bugs which had spent the winter in the incubator were returned to the *Neotoma* lodge.

As the 5th instar *T. rubida* began emerging to the adult stage in May, they were divided into 3 groups as follows: Group 1 (Fed-starved bugs) included 23 females and 22 males. They were fed once on *Neotoma albigula* after emerging, mated and kept in the *Neotoma* lodge until death, being weighed every 3 or 4 days. Group 2 (Fed bugs-unmarked) consisted of 8 females and 8 males. These were mated, fed weekly and kept in the *Neotoma* lodge in plastic vials until death. Group 3 (Fed bugs-marked) had 5 females and 7 males in it, and were treated the same way as Group 2 except they were marked with small paint dots on the thorax.

Besides these 3 groups, 80 bugs were not fed and were kept until they lost weight to near the average weight of bugs collected at the light. They were then marked and released along with bugs collected at the light.

Fertility of eggs laid was determined by microscopic examination and dissection of the eggs at least 1 month after they were laid. Eggs were classified in 3 ways: Hatched (empty egg chorion); Fertile, not hatched (partially or fully developed nymph visible through chorion); Not fertile (no development apparent).

RESULTS AND DISCUSSION

Light Collections

Totals

A total of 582 Triatominae were collected at lights and traps in Sabino Canyon in 1972 and 525 in 1973. These are listed in TABLE 2 by species and location.

At this elevation (853 m) *T. rubida* appears to be the most common Triatominae. It is interesting to note that *T. recurva* is more common than T. *protracta protracta* here. The host of *T. recurva* is still not definitely known although it has twice been found associated with rock squirrels, *Spermophilus variegatus grammurus* (Say) (=*Citellus variegatus grammurus*) (Ryckman et al., 1955; Ekkens, 1971). Rock squirrels are present in Sabino Canyon.

In the *Neotoma* lodges *T. rubida* is 11.3 times as abundant as *T. protracta* (10.9 to 0.96 per lodge). At the light (both seasons) 18 *protracta* were collected compared to 866 *rubida*. *T. rubida* was 48.1 times more common than *T. protracta*. *Triatoma protracta* comes to the light only 1/5 as often as one would expect from population levels in the nest.

The situation with *T. recurva* is somewhat different; at the light *T. rubida* is 5.25 times as common as *recurva* (866:165), but in *Neotoma* lodges *rubida* outnumbers *T. recurva* 215.25 to 1 (861:4). This indicates that the natural host of _T. recurva_ is not a _Neotoma_ sp. The 4 _N. albigula_ lodges where _T. recurva_ was found were on rocky slopes. The rocky slopes along the sides of Bear Canyon are inhabited by chipmunks, spotted skunks, rock squirrels and lizards as well as wood rats. It may be that _T. recurva_ is a more general feeder than most other North American Triatominae, living in rock piles and talus slopes and taking blood from any one of a number of vertebrates. This problem needs more study.

The fact that 5 nymphs of _T. recurva_ were found at the light is very interesting. It demonstrates that not all insects which are collected at lights fly there. One nymph was collected 4 times during the summer of 1972. It was a 5th instar nymph when collected on 20, 29 June, 24 September and 8 October.

Only 1 nymph of _T. rubida_ was collected at the light. That was a 4th instar nymph collected on 16 September 1972. Wood rats have been observed near the light. The closest wood rat lodge was across Breakfast Canyon, 30 m away.

In TABLE 2 a distinction has been made between Entrance Station and Entrance Station Trap. Around the Entrance Station there were some yellow anti-bug lights and a dim incandescent light that burned all night until the first of August in 1972. Almost as many bugs were found there as at the black light trap 46 m away. Both of these were quite poor collection sites. This is not to indicate that yellow lights are as attractive to Triatominae as are black lights.

Of the _T. rubida_ collected on Stikem traps, 2 were on the up-canyon side of the trap. The third 1 was on the lower edge of the trap, and it couldn't be determined which direction that 1 came from. Few captures were obtained at the Stikem traps.

The phone booth, situated across the road from the Old House, had a fluorescent light in it until 8 July 1972. The picnic area referred to in TABLE 2 is also across the road from the Old House. On 4 occasions (2 in 1972, 2 in 1973) visiting entomologists ran black lights there,and 1 of them also ran a light about 0. 8 km up the road (called Upper Road Light in TABLE 2). These entomologists gave me the Triatominae they caught. An additional _rubida_ was collected in the picnic area by a cyclist who slept 1 night on a cement picnic table in 1972. He brought the bug the next morning; it was found in his sleeping bag as he was preparing to leave. The only _rubida_ collected away from lights in 1973 was a female found in an outdoor toilet in the picnic area. In 1973 a lady showed me 3 females of _T. rubida uhleri_ that had approached her and her husband as they sat on rocks after dark near the Sabino Canyon stream. They had a flashlight on, so it is not known whether the bugs were attracted by the light or by their body warmth or odor. The bugs walked across the rocks from the direction of the stream.

Of 582 Triatominae collected in 1972 at lights, 12 had from 1 to 4 parasitic mites (Acari:Pterygosomidae:*Pimeliaphilus* sp.) attached to them. In 1973, 15 out of 525 adults carried them. One *Triatoma recurva* had a mite on it in 1972, 4 in 1973. The rest of the mite-bearing bugs were *T. rubida.* The mites were often found attached to the ventral surface of the body or to the basal segments of the legs.

Other Reduviids

The following predaceous reduviids were also collected at lights at Sabino Canyon, Pima County, Arizona.

Apiomerinae

Apiomerus flaviventris (Herrich-Schaeffer) - 1. VII. 1973. *A. longispinis* (Champion) - 22. VIII. 1972; 9, 18, 25. VII. 1973.

Ectrichodiinae

Rhiginia cinctiventris (Stal) (=*R. lateralis* Lepeletier & Serville) - 24(3), 25(2), 26(2), 27(2), 29(3). VI. 1972; 1, 6(2), 17, 18, 20. VII. 1972; 17. VIII. 1972; 17. VI. 1973; 3(5), 10(2), 16, 17(3), 18(3), 22(4), 29(2). VII. 1973; 1. VIII. 1973.

Emesinae

Stenolemoides arizonensis (Banks) - 23. VII. 1972; 3. V. 1973; 1(2), 10, 18(2), 22(2), 30(7). VII. 1973; 1(2), 4. VIII. 1973.

Harpactorinae

Zelus socius (Uhler) - 1. VII. 1972; 30 (2) V. 1973; 14 (3) VI. 1973;

3, 22, 30. VII. 1973.

Reduviinae

Pseudozelurus arizonicus (Banks) - 17. VII. 1973. *Reduvius senilis* Van Duzee - 14. V. 1973 Micropterous. *Reduvius sonoraensis* Usinger - 26. VII. 1972; 24. VI. 1973; 29, 30. VII. 1973; 1. VIII. 1973. *Zeluroides americanus americanus* Lent & Wygodensky - 26. VI. 1972; 6 (2), VII. 1972; 8(5), 9, 10, 16, 17(2), 18, 22, 29. VII. 1973; 1(2), 4. VIII. 1973.

Piratinae

Melanolestes picipes (Herrich-Schaeffer) - 20. VI. 1973; 30. VII. 1973. *Rasahus biguttatus* (Say) - 12, 13, 19, 31. VII. 1972; 12. IX. 1972; 1, 4(2). VIII. 1973.

Stenopodinae

Oncocephalus nubilus Van Duzee - 20. VII. 1972; 20, 29. VIII. 1972; 17. VII. 1973.

No predaceous reduviid species was present in adequate numbers to allow for firm conclusions concerning their flights. Some of the species appear to have their peak activity later in the summer than *Triatoma*.

All of the *Rhiginia cinctiventris* collected (15 in 1972, 15 in 1973) were males. Sigurd Szerlip (personal communication, 1973) stated that all light trap records of this species are males. Only 2 specimens of *Melanolestes picipes* were collected; both were early in the morning just before dawn (0415 hrs and 0430 hrs). Five specimens of Reduvius senilis and 1 micropterous R. sonoraensis were collected. R. senilis is found in Neotoma albigula lodges in association with kissing bugs (see section on Neotoma lodges). One individual of Apiomerus flaviventris was collected at the light. This bug is a diurnal insect which usually does not come to light (personal communication, Sigurd Szerlip).

Sex Ratios

Of the 31 adults of T. recurva caught in 1972, only 2 were females. The ratio in 1973 was 1:14.1 (9 females and 127 males). This high ratio of females to males is opposite to that of T. rubida uhleri. In 1971 when a colony of T. recurva adults were collected at Congress, it was noticed that the females took more blood than the males. In fact, in most species of Triatominae females appear to take more blood than males (Sjogren and Ryckman, 1966).

TABLE 3 and FIG. 6 show female to male ratios for T. rubida uhleri. As noted below, males were more numerous early in the season. For the first 3 weeks T. rubida uhleri came to the lights in 1973, the female to male ratio was 1:1.94.

By mid-July the female-male ratio rose until by mid-August the majority of bugs coming to light were females. The explanation of this is thought to be that males emerge first in the spring. Females emerge somewhat later.

Time of Day of Flights

One of the most important factors determining when bugs will fly is the time of day. Most Triatoma species that have been reported on have been observed flying during times of reduced light. Sjogren and Ryckman (1966) mention several reports of Triatominae being attracted to lights after dark.

Sjogren and Ryckman (1966) found only 4.6% of 398 T. protracta arriving before the light reached zero footcandle (ft-c) intensity. Most of their bugs (88%) came in during the first hour after dark. My results (FIG. 7) for Sabino Canyon are slightly different. In 1972 only 1 bug (a T. protracta) was caught before the zero ft-c intensity was reached. In 1973, 4 bugs, 1 T. protracta, 2 T. recurva and 1 T. rubida, arrived 4 to 10 min. before zero ft-c. That number only represents 0.8% of the total captures for the summer. On 2 of those nights, the sky was clear; on the other 2 nights the cloud cover was 10% and 70%. One T. rubida uhleri landed on the white pegboard 7 min. before dark under 10% cloudy skies before the light was turned on.

Eighty-seven percent of the bugs came to the lights during the first 4 hours after dark. The flights of T. rubida in Sabino Canyon are spread out more than those of T. protracta in California.

The activity of the bugs soon after dark is a result of 2 factors:
1. The data indicates that onset of darkness is the triggering mechanism

for the flights. Soon after dark most of the Triatoma bugs that are going to fly, do so; therefore, even if the weather warms up in the early morning hours, very few bugs fly. 2. After dark the temperature falls fairly steadily so that before midnight the temperature is often low enough to restrict flight.

On a number of occasions when the light was operated all night, I observed that the temperature at the collecting site rose about 0300 hrs. This was caused by a shift in wind direction or when the wind began blowing after a calm period. This rising temperature was never followed by a flight of bugs. One T. recurva arrived at the light at 0350 hrs, which was approximately 1 hr before dawn, but bugs were quite rare after 0200 hrs even on nights when the temperature remained high. The latest bug caught before daylight was a male on 19 August at 0400 hrs. This bug was on 1 of the board supports of the light and could have come in earlier in the night and may have been hiding under the board.

Importance of Physical Factors

TABLES 4-9 and FIGS. 8-13 show the effect of the various physical factors (moonlight, air temperature, relative humidity, wind speed and direction, cloud cover) on flights of 3 species of Triatoma.

The results of the step-wise regression are given in TABLE 11. From this TABLE it appears that temperature and wind speed are the

2 most important physical factors affecting the flights of Triatoma rubida uhleri. High temperature and calm (or virtually calm) air promote flights. This seems to agree with FIGS. 8-13 except that in FIG. 11 it appears that the most bugs flew at a wind speed of 12.8 km/hr. However, this high value is based on only 7 individuals which were collected in a relatively short period of time. In the over-all view, many more bugs were caught at lower wind speeds.

Low relative humidity seems to promote flights of T. rubida. However, this is probably the inverse effect of temperature. Temperature and relative humidity are the 2 physical factors that are the most highly correlated with each other (TABLE 11).

For Triatoma recurva, the results of the step-wise regression appear to be different. The 2 physical factors that are most highly correlated with large numbers of T. recurva are low relative humidity and some wind movement. It is very important to add that this is within a rather narrow temperature range. Very few hours were spent operating the light below 22°C. Within the temperature range 26° to 33°C, the numbers of T. recurva coming to the light fluctuated randomly. Below 26°C very few bugs came to the light. Cool temperatures restrict flights. Very few nights were encountered with after-dark temperatures above 36°C.

The effect of air movement on the 2 species (T. rubida and T.

recurva) is different. It is important to stress that this is air movement within a definite range (0 to 12.8 km/hr). Wind velocities above 13 km/hr were very rare; *Triatoma* were never collected at wind speeds above this velocity. Somewhat stronger air movement seems to promote flights of *T. recurva* while repressing *T. rubida* activity. Because *T. rubida* is a smaller insect than *T. recurva*, it may well be that they are affected more by air movement than *recurva*.

Sjogren and Ryckman (1966:87) found that *T. protracta protracta* in California had little dependence on humidity. The 1 group of insects that were noticed to be more abundant after rains were the aquatic insects. On the nights of precipitation, the temperature was usually cool and few insects flew. The next night, if warm, many insects were flying; and aquatic insects, i. e. gyrinid and dytiscid beetles were especially abundant. *Triatoma* were not more abundant than usual on nights of high humidity.

In 1971 *Triatoma rubida uhleri* were collected at a light on 2 consecutive nights, 19 and 20 July. In the first 4 months of 1971 Sabino Canyon had 3.56 cm of rain. The first measurable rain of the summer fell on 14 July. A total of 1.22 cm fell from 14-18 July. On the 19th a trace of rain fell early in the evening before sundown, and 36 *T. rubida uhleri* came to the light. On 20 July no rain fell; and a total of 83 *T. rubida* and 2 *T. recurva* were collected, the greatest number of bugs to be collected in 1 night in this study.

On a few nights in 1972 and 1973 rain fell early in the evening followed by a rise in temperature. This occurred on 22 July and 27 July 1972. On 22 July it rained a few drops at 1930 hrs, but the humidity was not affected. Two female rubida came in about 2100 hrs at 28.6°C. From 2135 to 2155 hrs 2.5 mm of rain fell, and the temperature dropped to 22.2°C. At 2141 hrs (23.3°C) a female *T. rubida* was found on 1 of the support boards for the light. She may have come in before the rain began. After the rain stopped the temperature rose to 25.5°, and a male rubida was caught at 2236 hrs.

On 27 July 1972, 1.27 cm rain fell from 1830 to 1900 hrs; this cooled the air down to 20°. After the rain stopped, the temperature rose to 25.5°. The wind was very intermittent, and the temperature rose and fell in response to it. Three *T. rubida* (1 female and 2 males) arrived at 2051 hrs (30°), 2212 hrs (26.1°) and 2222 hrs (26.7°) respectively.

On 8 August 1972, 0.05 cm rain fell just before sundown; the air temperature dropped from 36.7° to 22.2° in 2 hr (1700 to 1900 hrs). After the rain the temperature stayed cool (22.8-24.4°C). Three female rubida were collected: 2040 hrs (23.3°), 2043 hrs (23.6°), and 2110 hrs (24.4°).

On 3 July 1973, a trace of rain fell from 2005 (dark) to 2020 hrs.

Almost as soon as the rain was over, the pavement was dry. Fifty-three T. rubida uhleri were collected that night, which was the maximum number collected in 1 night in 1973. The temperature that night was favorable for flying until early morning (26.7° to 33.9°C or 80° to 93°F).

If rain fell early in the day and the air temperature was warm after dark, the numbers of T. rubida collected were normal. TABLE 10 is a list of the days rain fell in Sabino Canyon, the number of bugs caught that night and the average number of bugs per night recorded for that week. Most nights that rain fell the number of bugs collected was below normal for that week. On 15 and 23 July and 6 August 1972 the bugs all came in before the rain. The rain on 7 August 1972 was only a trace, and the temperature that night was normal.

FIGS. 14 and 15 compare rainfall by week with number of Triatominae per night for each week. From these graphs it is apparent that rainfall doesn't promote flights. Instead, rainfall seems to stop flights. In weeks when rainfall was high, bug captures were low. This may be due to the lowered temperature during rainy weeks.

Wood (1950, 1954) refers to the relation of flights of T. rubida and T. recurva (=longipes) to the beginning of the summer rains. In his 1954 paper he quotes various National Park Service employees as saying that Triatoma were not seen until the summer rains began in early July.

The first measurable rain of 1972 at Sabino Canyon was on 29 May (except for 0.03 cm in March) (TABLE 1). The total rainfall for 1972 before collection began on 19 June was 2.47 cm. Only 4.70 cm of rain had fallen by 13 July, which was the week in which the largest number of bugs were captured.

The winter and spring of 1973 were much wetter than usual (TABLE 1). The summer rains began 1 July, during which week the most bugs flew. There was 0.53 cm (0.21 in.) on 1 June and 1.65 cm (0.65 in.) on 13 June. However, the bugs began flying before these rains. FIGS. 14 and 15 show that the greatest number of bugs were usually caught the week before (or, in 1 instance) the week of greatest rain. This may be due to the fact that the mean temperature is higher during those weeks (FIGS. 16 and 17). The beginning of the flight season seems to be more closely related to rising temperatures than to the start of the summer rains.

In 1971, 17 adult _T. rubida_ and 15 adult _T. recurva_ were collected at lights (6 nights) at Congress, Arizona, 16-22 June. Rainfall for the first 8 months of 1971 at Congress was: January - 0.05 cm, February - 2.13 cm, March - 0.20 cm, April - 0.56 cm, May - 2.79 cm, June - 0 cm, July - 0.38 cm, August - 6.96 cm. The summer rains had not started when the _Triatoma_ were collected and did not start until early

August. Thus it is apparent that bugs fly before the onset of the summer rains.

Temperature during the flight period is an important index for determining on which nights the greatest flights of bugs will occur. FIGS. 16 and 17 graph mean night temperature and relative humidity against number of Triatoma. From these graphs it may be seen that temperature during the flight period is more important than relative humidity.

The results of the step-wise regression test agree with my experience in the field in regard to wind and temperature. T. rubida uhleri flew best under conditions of high temperatures and calm winds, but T. recurva seemed to fly over a wider range of temperature and wind speeds. The fact that humidity was the most significant physical factor affecting flights of T. recurva is surprising. However, humidity is not so easy to sense as air temperature or wind to the human observer. No T. recurva came to the light below 22°C.

The other factor that could be affecting flights is the microtemperature where the bugs reside during the day. Soon after sundown the temperature of the whole environment begins to cool. The air temperature that is being measured at the light is only 1 component of the environmental temperature. By 0300 hrs the temperature in the wood rat nests where the bugs were has fallen so that the bugs are less active. The tempscribe charts never showed a rise in temperature in the *Neotoma* lodge in early morning.

With respect to moonlight *Triatoma* flights appear to be random. TABLE 4 shows that bugs flew under all conditions of moonlight. This is similar to the results reported for *T. protracta* (Sjogren and Ryckman 1966).

A physical factor that has a dramatic effect on the temperature is the wind. In Sabino Canyon when there is movement of air, the ambient temperature rises, or, if it falls, falls very slowly. As soon as the wind stops the temperature begins to fall. If the wind blows again, the temperature will rise again. FIG. 18 shows a copy of a hygrothermograph recording of 7 June 1973, when this situation occurred several times.

The explanation evidently is as follows: when the wind is calm, the cool, heavy air up on Mt. Lemmon moves down the canyons and the temperature falls rapidly. If the wind begins blowing, it mixes this cool air with the warm air of the desert and raises the temperature. The net effect on *Triatoma* flights is that air movement tends to keep the temperature up within the flight range for a considerable period of time. It is thought that this is the main reason that *T. rubida uhleri* and *T. recurva* flew longer into the night than has been reported for *T. protracta* (Sjogren and Ryckman 1966). In mid-summer in southern

California the temperature usually cooled off to 21.1°C by 2300 hrs, but in southern Arizona many nights were encountered when the temperature never became that cool all night.

Stikem Trap Captures

Very few bugs were caught by the Stikem traps. The largest trap used (2.4 m^2) only samples a very small fraction of the cross sectional area of a canyon 50 m wide by 15 m deep. One *Triatoma rubida uhleri*, a female, was caught on the first trap. The second trap caught no *Triatoma*, but it collected 14 buprestid beetles from 25 July to 13 August 1972. Some of these buprestids were sent to Dr. G. H. Nelson who identified 3 species among them: *Polycesta velasco* Lap., *Chrysobothris octocola* LeC. and *C. peninsularis* Schffr. The third Stikem trap (2.4 m^2) caught 2 *T. rubida* in late summer of 1972. In 1973 no bugs were trapped on this Stikem trap.

Mark-Release-Recapture Studies

Results

TABLES 12 and 13 give the result of the mark-release-recapture studies. Thirty-four *Triatoma rubida* (9.16% of releases) and 4 *T. recurva* (13%) were collected again in 1972. In 1973, 7 *T. rubida* (2.2%) and 3 *T. recurva* (2.3%) were recaptured. The recapture rate was considerably lower in 1973 due to 2 factors: Bugs were released farther from the light in 1973 and more down-canyon release sites were used.

The majority of bugs that were recaptured, returned either the same night they were released or the next night the light was operated. There were 4 very interesting exceptions to this: #313, a male *T. rubida*, which was captured 15 July 1972, released at "Breakfast" 17 July and caught again on the 30th, 13 days after release; #425, a female *T. rubida*, caught 19 July 1972, released the 20th at "Down" and returned on 17 August, 28 days later; #1424, a female *T. rubida*, released 14 June 1973 at "Pump House Trail" and returned to the light on 26 June, 12 days later; #123, a male *T. recurva*, released 10 July 1973, and returned to the light 22 July, 12 days later.

These 4 bugs are further evidence that the flight of *T. rubida* and *T. recurva* observed in Sabino Canyon is not a population dispersal flight. If this were a true dispersal flight, once the bugs were dispersed, they would not need to fly a second or third time.

It seems that these bugs fly due to a physiological stress (starvation). When the physiological stress occurs again, the bug will fly again. (See below under physiological condition).

Down Canyon Flights

Wood (1943, 1950) refers to down-canyon flights of *T. rubida uhleri*. Down-canyon release points were selected in Sabino Canyon to observe if the flights are primarily in 1 direction or if the bugs fly toward a light from all directions. On 2 nights (1 July and 12 July 1972) returns were obtained from several release points on the same night. On 1 July, 1 marked bug came from each of the following: "Down", "One Way", and "Breakfast". On 12 July, 2 returns were received from "Breakfast" and 1 each from "One Way", "Down" and "Road Y".

The 1972 percentage of recaptures from "Down" (11.6%) is close to the average return rate of 9.5%. In 1973 when release points were farther from the light and out of sight, returns from down canyon (1.6%) were less than from up canyon (2.9%).

This does not mean that the bugs were actively flying up or down canyon, because in 1972 68.8% of the wind was blowing down canyon and only 4.1% was blowing up canyon; in 1973 down wind was 38.1% and up wind 11.9%. Air movements must have a significant effect on relatively slow-flying Triatoma. Hence, when the total data are considered, it is evident that the Triatoma fly at random up or down canyons, but their flights may be altered by air movements.

Of the 8 Triatoma that returned from "Down" in 1972, 4 came back the same night they were released. These 4 were released and returned on the following days: 27 June, 1 July, 12 July and 18 July. The following notes on wind refer to the time from the release of the Triatoma to recapture at the light: 27 June, wind blowing down main canyon-NE; 1 July, wind blowing from West (across canyon); 12 July, wind West at 4.8 km/hr; 18 July, wind down main canyon (NE) at 8 km/hr.

From this data it is concluded that the flights of *T. rubida* are random. The fact that *N. albigula* often builds lodges up on the sides of hills or canyons, coupled with the fact that if there is a house nearby, it may be at a low part of the canyon, would produce down-canyon flights of the *Triatoma* if they flew toward the lights, as noted by Wood (1943).

Studies of Neotoma Lodges

Collections

Out of 79 *Neotoma* lodges examined, 63 (79.7%) contained 1 or more *Triatoma* species as follows: *Triatoma rubida uhleri* - 861 (10.9 bugs per nest); *T. recurva* - 4 (0.05 per nest); *T. protracta protracta* - 76 (0.96 per nest). Nine individuals of *Reduvius* were found. These are assassin bugs reported to occupy *Neotoma* lodges, and Ryckman & Ryckman (1967) state that they feed on Triatominae. At no time was a nest found which contained *T. protracta* or *T. recurva* without *T. rubida* also being present. One nest had no live *Triatoma* spp., but there were 2 exuviae of 5th instar *T. rubida* nymphs and a *Reduvius* adult.

Life Cycle Information

Triatoma recurva

All *T. recurva* found in *Neotoma albigula* lodges were nymphs (1 2nd, 2 3rds, and 1 5th instar). One was collected 4 February 1973; the other 3 were obtained in July and August 1973. Circumstances of these collections indicate that *T. recurva* probably was attracted to other nearby hosts which were closely associated with the *Neotoma* lodges. This is not to imply that *Neotoma* are the reservoir host for *T. recurva*.

Triatoma protracta

Triatoma protracta appears to be found in all instars during most months of the year. TABLE 14 combines the collection of *T. protracta* for 1972-1973 by seasons.

It appears that in the spring 5th's are emerging to the adult stage, giving a high percentage of adults. By summer the adults which overwintered as adults are dying off, and their eggs are hatching. This causes a rise in the percentages of small nymphs and a drop in number of adults. By fall, 5th instar nymphs (that became 5th's in summer) have become adults, raising the percentage of adults. At the same time, more small nymphs have moved up to the 5th instar causing a drop in relative number of small nymphs and increasing the relative number of 5th's. During the winter very little development occurs unless they are transferred to warmer temperatures.

Triatoma rubida uhleri

The situation with *T. rubida uhleri* is quite different. Adults were found only during late spring and summer (TABLE 15). As winter approaches the numbers of 5th instar nymphs rise to near 90%, and this condition continues until spring. The time when the first adults emerge probably varies considerably from year to year. The spring of 1973 was cooler than average (TABLE 16); March was 3.3°C cooler than normal, and April was 2.33°C below normal. During a spring that more closely approached the normal, adults of *T. rubida* would very likely appear earlier. Dr. Ryckman's unpublished records show adults of *T. rubida uhleri* in *Neotoma* lodges in southern Arizona in April.

The first adult of 1973 was found on 15 May. The temperature of 1 *Neotoma* lodge in Bear Canyon was rising rapidly at that time. This is the lodge in which many nymphs of *T. rubida* and *T. protracta* were kept until they emerged. In this lodge the first adult *rubida* emerged on 21 May. This lodge is under a large rock on a northern exposure slope. A lodge on a south-facing slope would receive more sun and could well have warmed up earlier. Also, the bugs in the vials were restricted in their movements; they were fed once a week.

Triatoma rubida uhleri evidently over-winters in all nymphal stages. In spring and early summer metabolic activity increases and molting occurs. Adults emerge and lay eggs; the hatching of these eggs produces a high number of small nymphs in midsummer. Two Neotoma albigula lodges examined in August contained 57 Triatoma each. One lodge contained 57 nymphs of T. rubida; the other 55 nymphs of T. rubida, a 5th instar T. recurva and an adult male T. protracta.

As can be seen in TABLE 15, adults of T. rubida were found in Neotoma lodges in May, June, July and early August of 1973. From July to October 1972, 16 Neotoma lodges were examined without finding any adults.

Other investigators have also reported not finding adults of T. rubida from late summer to early spring, but they have found T. protracta during that period. Wehrle (1939) reports collecting adults of T. protracta from Neotoma lodges near Tucson during November, December, March and May. The only adult T. rubida reported in that paper was collected in May.

Ryckman's unpublished records follow this same general pattern (personal communication 1972). He found adults of T. rubida uhleri in Neotoma lodges in southern Arizona and northern Mexico during April, May and June; but none after that.

Vince Brach (personal unpublished records 1972) found several adults of *T. protracta* and nymphs of *T. rubida* in *Neotoma* lodges in December near Vail, Arizona. In June he collected 4 adults of *T. rubida* from a *N. albigula* lodge.

Light trap collections in 1972 dropped to a very low level after the end of August even though some warm evenings occurred in September. This, and the fact that adults were rare in *N. albigula* lodges after July, indicates that adults are dying off by midsummer. Because of the low population density of *Triatoma rubida uhleri* adults in *Neotoma* lodges in September, it is thought that collection at a light is a more sensitive indicator of the presence of *T. rubida uhleri* adults in a given locality than examination of *Neotoma* lodges.

Field and Laboratory Culture of Triatoma

As indicated above, some *Triatoma* nymphs from *Neotoma* lodges were maintained in a *Neotoma* lodge in plastic vials all fall, winter and spring while others were kept in an incubator (26.7°C) from 24 October 1972 to 8 April 1973. This latter group was returned to the *Neotoma* lodge on 8 April where they remained the rest of the spring and summer.

The only *T. rubida* nymphs that became adults before late May were 2 males that were collected 4 March 1973 as 5th instar nymphs and held in the incubator until 8 April 1973 when they molted to adults. Fifth instar nymphs were taken to the incubator in October, November, December and February also, but none of these became adults until late May. Nymphs below the 5th instar which were maintained at 26.7°C molted through the winter (TABLE 17).

By way of contrast, Triatoma protracta nymphs at 26.7°C molted readily to adults all during the year. A 5th instar T. protracta collected 18 December 1972 and maintained at 26.7°C molted to adult on 6 February 1973. One collected 5 February 1973, molted to adult on 19 March 1973. One collected 4 March 1973, molted to adult on 8 April 1973. A 1st instar nymph collected on 18 December 1972 molted 5 times (6 February, 12 February, 8 April, 14 May and 9 July); the last molt produced the adult.

It appears that while Triatoma protracta has a weak diapause (which can be induced by cool temperature and broken easily by warm temperatures), T. rubida has a more intense diapause. Most individuals go into a diapause in the 5th instar, and exposure to warm temperatures does not break diapause soon. Their entrance into diapause is evidently controlled by temperature and/or time of year.

Twenty-seven adults of T. rubida emerged the first 2 weeks of June (compared to 154 during the last 11 days of May). These were mostly bugs that had been collected as 5th instar nymphs in April, May and June 1973. During the last 2 weeks of June, 24 adults emerged; these were mostly bugs that had been collected as 4th instar nymphs in April and molted to 5th instar in May. Only 6 nymphs of T. rubida emerged to adults after 25 June. One of these (#1498) was collected as a 5th instar nymph on 15 June. The other 5 bugs (#'s 1480, 1481, 1482, 1486 and 1497) were collected as 4th or 3rd instar nymphs. Collection dates and other data about these bugs can be seen in TABLE 17. The last _T. rubida_ adult to emerge was #1497 in late August.

It appears that while the 5th instar is a true diapausing stage in _T. rubida_, nymphs entering this stage in May do not diapause but proceed directly on to the adult. This situation has been reported for the dragonfly _Anax imperator_ Leach (Corbet et al. 1960). All during June and July many _T. rubida_ nymphs were entering the 5th instar, but most individuals remained in that stage and did not molt to adults.

Entrance into diapause does not appear to be controlled exclusively by temperature. Temperatures remained high well beyond 5 July, but few 5th instar nymphs molted after 25 June.

Once the 5th instar _T. rubida_ nymphs began molting on 21 May, there didn't appear to be much correlation between collection date and emergence date. Those that were collected from _Neotoma_ lodges in October and held in the laboratory incubator all winter and fed weekly molted to the adult about the same time as those that spent the entire fall, winter and spring in the _Neotoma_ lodge in plastic vials and were fed once a month (sometimes less frequently) during the winter.

The emergence of _T. rubida_ could well be termed "explosive" as

80% of the males emerged the first week (21-27 May). Females are somewhat slower in their emergence with only 48% emerging the first week. This was also seen in the "wild" *Neotoma* nests. Of the 19 adult *T. rubida* taken from *Neotoma* lodges in May, 15 were males and 4 females. The light collections also followed this pattern. Males totaled 66% of the collections during the first 3 weeks *rubida* came to the light.

Starving Rates and Life Span of *T. rubida*

Starving Rate

In a study of the dusky-footed wood rat, *Neotoma fuscipes*, Baird in California, Linsdale and Tevis (1951:497) found that the wood rats often stayed in a lodge for as little as 1 or 2 months, and then that lodge would be vacated for a period of time. The average length of residence in a lodge by a single wood rat was 2.9 months. This vacating of the lodges may occur voluntarily, or involuntarily through predation. Linsdale and Tevis considered great-horned owls and wildcats (both found in Sabino Canyon) the major predators of *N. fuscipes*.

If the lodges were vacated, the bugs would soon be under stress to obtain a blood meal. Starving rate of *T. rubida* is shown in TABLE 18. Average life span after feeding was 19.4 days for females and 19.9 days for males. Females required an average of 15.6 days (males

15.5 days) to lose weight down to average flight weight. These bugs then lived an average of 3.9 (female) and 4.4 (male) days after reaching flight weight.

If a Triatoma rubida found itself without a rat host, it is predicted that the bug would find it necessary to leave the lodge within about 15 days following its last blood meal. Average life expectancy after flying from the rat nest would be about 4 days unless a new host were found.

The flight-starved females lived an average of 2.5 days, the males 2.9 days (TABLE 19). This is somewhat below the average life expectancy for the fed-starved bugs referred to above. This could be due to greater stress on bugs in nature than in the vials.

Females lose weight more rapidly than do males; but because they take more blood than males do, the percentage loss is about the same for both sexes. TABLE 18 shows the data for average starving rates of 23 females and 22 males (fed-starved bugs). Percent lost per day is very similar for both sexes. Females lose slightly more (total and per day) due to egg production, as mentioned above.

Average rates of starving and confidence intervals were calculated for each sex from the weight lost per day. These are shown in FIGS. 19 and 20. For each adult bug collected at the light or in a Neotoma lodge one can predict from its weight the number of days left until death for that bug. For example, it is possible to predict how long a bug has left to live when it comes to the light. In reading up above 82.3 mg (mean weight of females in 1973), look for the "mean line". Move across to the left to see that the average female has an average of 3.5 days left until death. The 95%, 90% and 80% confidence limits are: 0-8.5, 0.1-7.6 and 0.2-6.6 days respectively. For males (1973 mean weight 58 mg) the average is 4.4 days.

When the 25 flight-starved bugs were subjected to this test (FIGS. 19 and 20), 21 were within the 95% confidence limits of predicted life span after capture (TABLE 19). One female and 1 male lived longer than expected; 1 female and male died sooner than expected.

Life Span of Fed Bugs

When _T. rubida_ bugs are fed weekly, their life span is greater than those that are fed only once. TABLE 20 shows the life span for fed bugs, both marked and unmarked. The normal unmarked bugs had an average life span of 43.1 days (females) and 67 days (males). Marking hastens death considerably, although laboratory tests with _T. lecticularius_ showed that it didn't. Marked females lived only 37.8 days, males 27.7 days. Also, marking lowered the fecundity and fertility of females (TABLE 20).

For laboratory-reared (control group) _Triatoma rubida rubida_ (Uhler), Nyirady (1973) gives 78 days (females) and 76 days (males) for the average life span compared to 206 days (females) and 204 days (males) for T. protracta. The difference between Nyirady's results and those of the present study may be that in this study the bugs were kept in the wood rat lodge. Temperature in summer sometimes exceeds 37°C in the wood rat lodges.

Physiological Condition of Flight Collected Bugs

Nutritional Condition

Because most bugs were released alive for other studies, it was not possible to dissect each bug to determine its physiological condition. The external appearance of all but 1 or 2 of the Triatoma spp. collected was that of starvation; the abdomen was concave.

The weight of bugs was used to determine how near the bugs were to death. In 1972 the mean weight of 193 females was 80.0 mg and of 98 males 57.0 mg. In 1973 the mean weight of 198 females was 82.3 mg and of 179 males 58.1 mg. As mentioned in the section on starving rates, these bugs are near death.

The range of weight of flight-collected females was 56.0 to 168.7 mg, but 87% were between 70 and 120 mg. For males the range was 32.0 to 99.6 mg; 86% were between 40 and 70 mg.

In 1972, 11 females and 5 males were fed after being collected at the light. Mean fed weight was 198.6 mg (females) and 103.3 mg (males). This would represent a weight gain of 118.6 mg (148% gain) for females and 46.3 mg (81% gain) for males. Sjogren and Ryckman (1966) had a weight gain of 121.7% for 1 female and 71% for 11 males of T. p. protracta.

In 1973 several females of T. rubida collected at the light weighed more than usual and were retained for further study. One of these was found in a sleeping bag and may have fed on the occupant during the night. Another bug laid 13 eggs (11 within a week after capture) without being mated; 11 of these (85%) were fertile. Another bug laid 8 eggs (85% fertile) within a week of capture. One female weighed 168 mg and was found (by dissection) to contain 47 eggs.

Fertility and Fecundity of Females

Females collected at the light were usually fertile, hence these flights were not mating flights. Of the 46 Triatoma rubida females retained until death, 23 laid a total of 203 eggs (8.8 eggs per female) (See TABLE 21). Twenty-three laid no eggs (TABLE 24) perhaps because they failed to feed sufficiently following capture or they may have been older bugs than the ones that laid eggs. It was observed that some bugs did not take blood readily from the rat when the bugs were confined to plastic vials.

The possibility that the bugs mated in flight was ruled out because no female ever deposited a spermatophore after capture. Ryckman

(1962:164) reports that the majority of females drop their spermatophore between 30 to 43 hr after mating. Several females were held for 30 hr or more, and 46 were held until death. None of these dropped a spermatophore although several laid eggs (TABLE 21).

Of the 23 T. rubida which laid eggs, 2 laid 1 non-fertile egg each; the other 21 females laid 201 eggs, of which 150 (74.6%) were fertile. This compares very favorably with a 77.5% fertility rate for newly emerged females which were fed at least once and mated.

TABLE 22 gives the data for females fed only once; TABLE 23 presents the data for females that were fed weekly. It is not known why 2 fed-starved females (#'s 1264 and 1268) laid all non-fertile eggs.

The 8 females that were fed weekly laid 68.75 eggs per female (TABLE 23) while the 23 flight-collected females that laid eggs laid only 8.8 eggs per female (TABLE 21). These flight-collected bugs lived an average of 16 days compared to 54.1 days for females which were fed weekly from emergence to death.

The lower fecundity and the shorter life suggests that the flight-collected females are older insects and/or an indication of greater stress on starved insects in nature.

CONCLUSIONS

From the forgoing data it seems evident that the primary cause of the flight of *Triatoma* is starvation as has been reported for *Triatoma protracta* (Sjogren and Ryckman 1966). The bugs arrive in a starved condition and die within a few days if not fed.

The main physical factors promoting large flights of *T. rubida uhleri* are the following: high after-dark temperatures, low relative humidity and relatively calm air. For *T. recurva* wind is not so great a deterrent, except high winds. High air temperature and low humidity promote flights of *T. recurva*.

The beginning of flights in early summer is more closely related to rising night temperatures than to the beginning of summer rains. *T. rubida* adults are more abundant early in the summer (June and July) than later. This evidently is because *T. rubida* over-winters mainly in the 5th (last) nymphal instar. As soon as mean air temperatures rise to 23.3°C (74°F), the 5th instar nymphs begin molting to adults. Soon after this, warm night temperatures allow flights to begin.

The flights of the bugs appear to be randomly directed. The position of the *Neotoma* lodges high on the sides of the canyon with winds often blowing down canyon after dark produces more passive movement in the down-canyon direction.

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Figure 1. Topographical map of Sabino Canyon and surrounding area. Circled numbers indicate specific study sites. 1-Old house; 2-Entrance station; 3-Lowell ranger station; 4-Walter Ormsby's residence and lower Sabino light; 5-*Neotoma* lodge which contained Tempscribe; 6-8-Location of *Neotoma* lodges which were examined: 6-Bear Canyon, 7-Esperero Canyon, 8-Ventana Canyon.

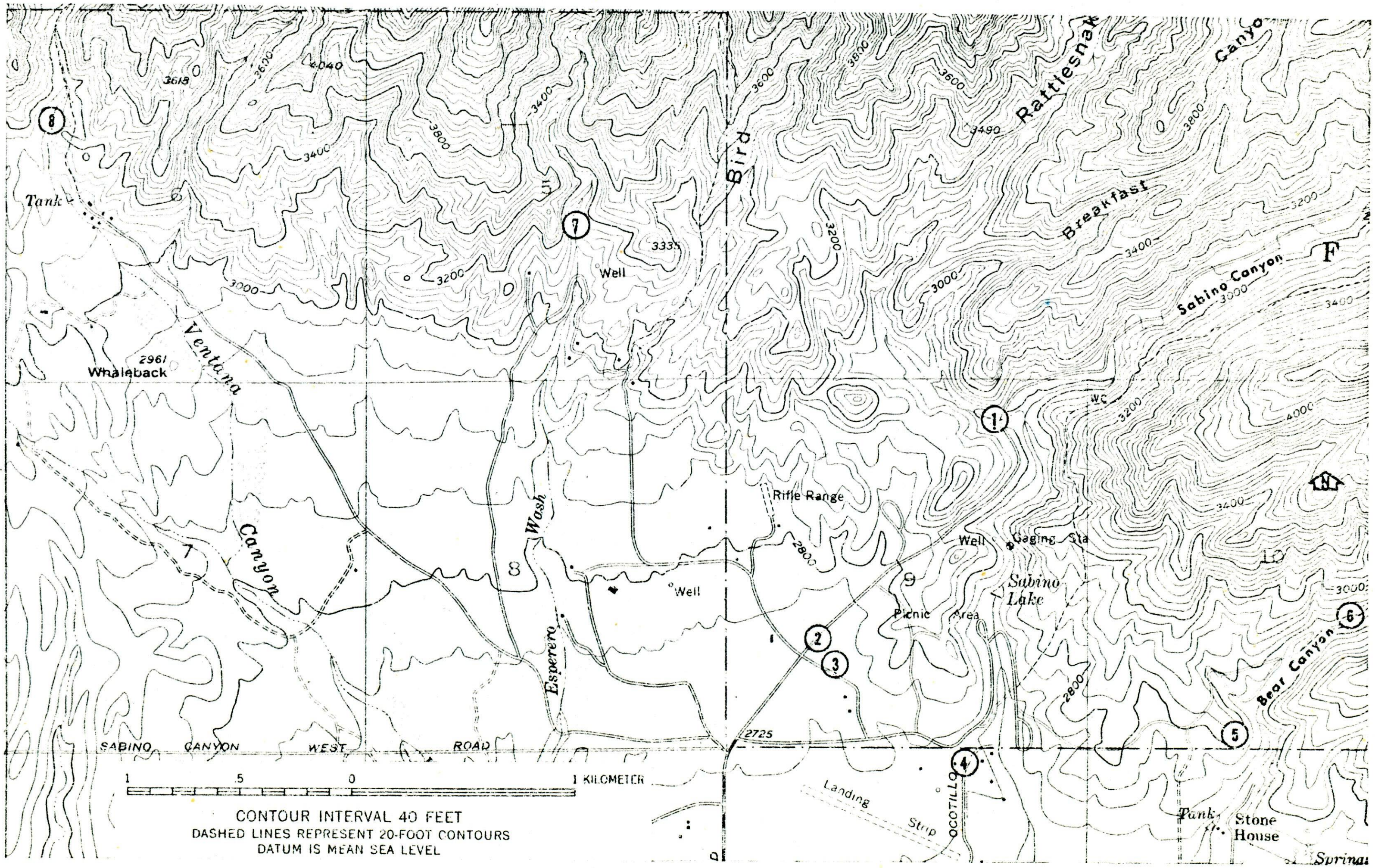

Rattlesnake
Canyon
Bird
Breakfast
Sabino Canyon
F
Tank
Whaleback
2961
Ventana
Canyon
Wash
Esperero
Well
Rifle Range
Gaging Sta
Sabino Lake
Picnic Area
Bear Canyon
Landing Strip
OCOTILLO
Stone House
Tank
SABINO CANYON WEST ROAD
2725
3618
4040
3335
3490
1 .5 0 1 KILOMETER
CONTOUR INTERVAL 40 FEET
DASHED LINES REPRESENT 20-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

Figure 2. View of the collecting site. Arrow indicates Breakfast Canyon right center in distance, view from the east side of Sabino Canyon. Note car and white peg board in the center of the picture. Picnic area and phone booth are in the center foreground.

Figure 3. Detailed map of collecting area. 1-Old House (main light); 2-Stickem traps; 3-Phone booth and picnic area; 4-13-Release sites: 4-Down, 5-River Trail, 6-Pump House Trail, 7-Lower Sabino Trail, 8-Breakfast, 9-One Way, 10-Road Y, 11-Mesquite, 12-Km 0.4, 13-Flood Gate, 14-Km 0.8.

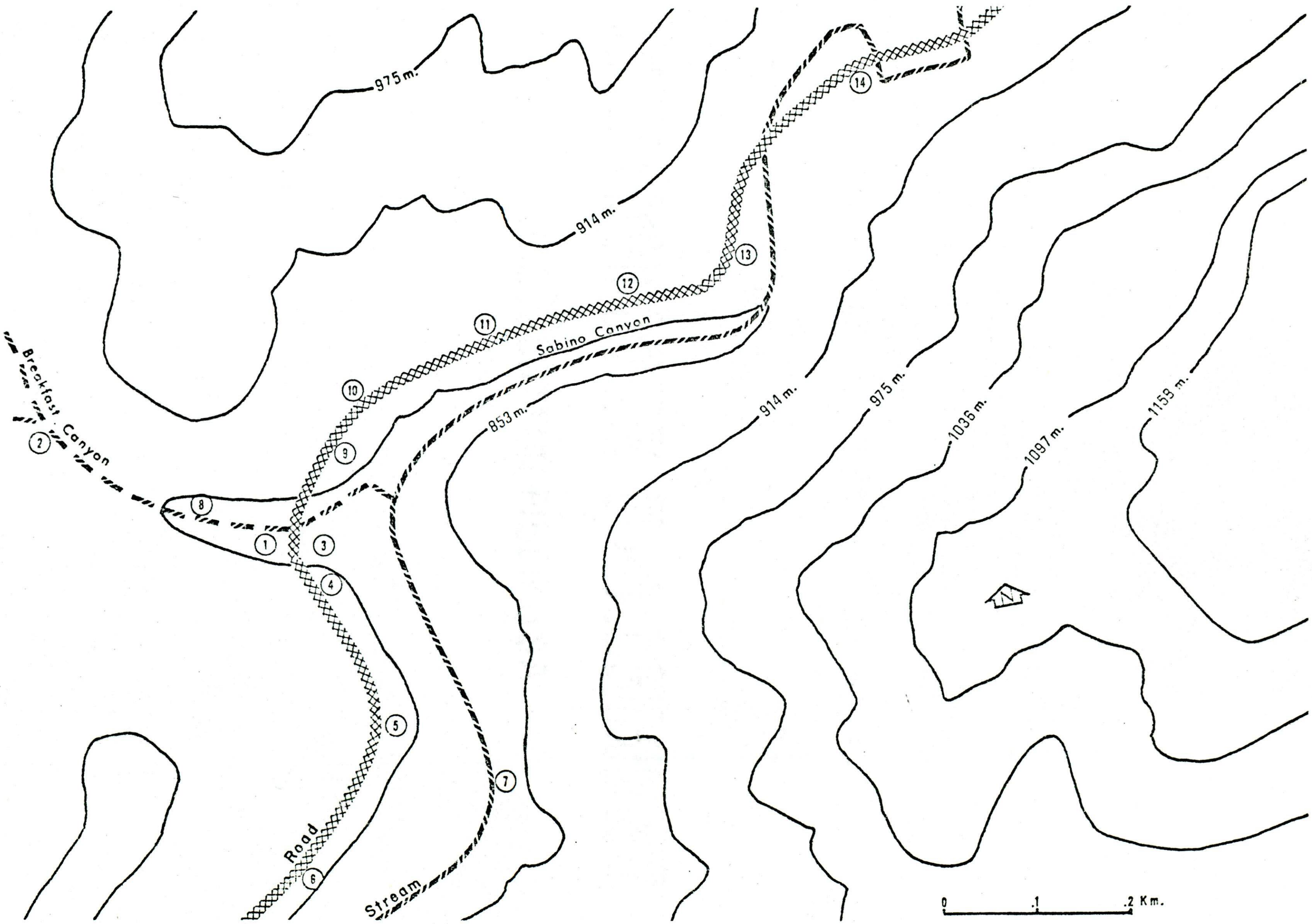

975 m.
914 m.
Sabino Canyon
Breakfast Canyon
853 m.
914 m.
975 m.
1036 m.
1097 m.
1158 m.
Road
Stream
N
0
.1
.2 Km.
1
2
3
4
5
6
7
8
9
10
11
12
13
14

Figure 4. A typical lodge of *Neotoma albigula* in Bear Canyon. The majority of the nesting material is out of sight in an opening in the rocks (arrow).

Figure 5. The *Neotoma albigula* lodge in Bear Canyon in which the Tempscribe and bugs were kept. The bugs were kept behind the Tempscribe under the large rock.

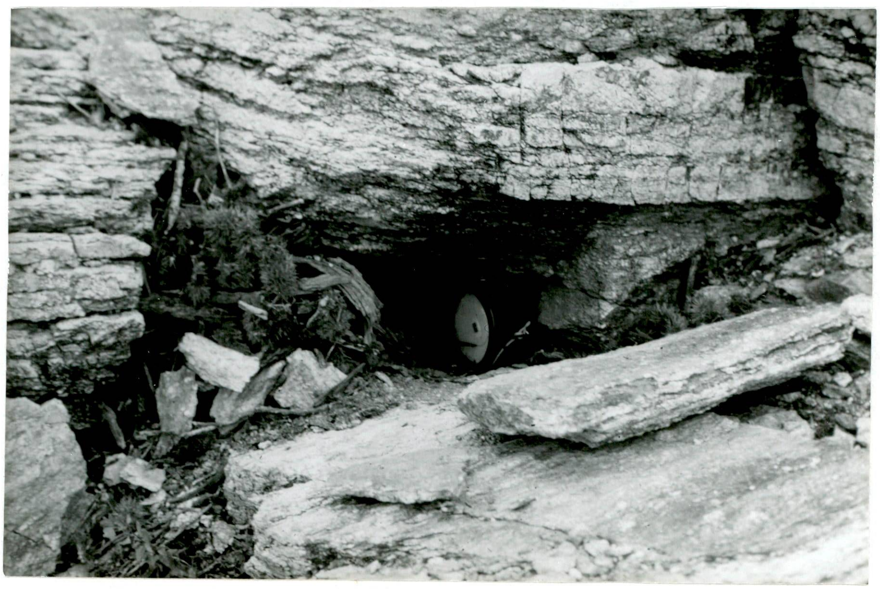


Figure 6. Sexual distribution of <u>Triatoma rubida uhleri</u> collected at lights, 1972 and 1973. Weeks 21 June through 10 Aug include data from both summers.

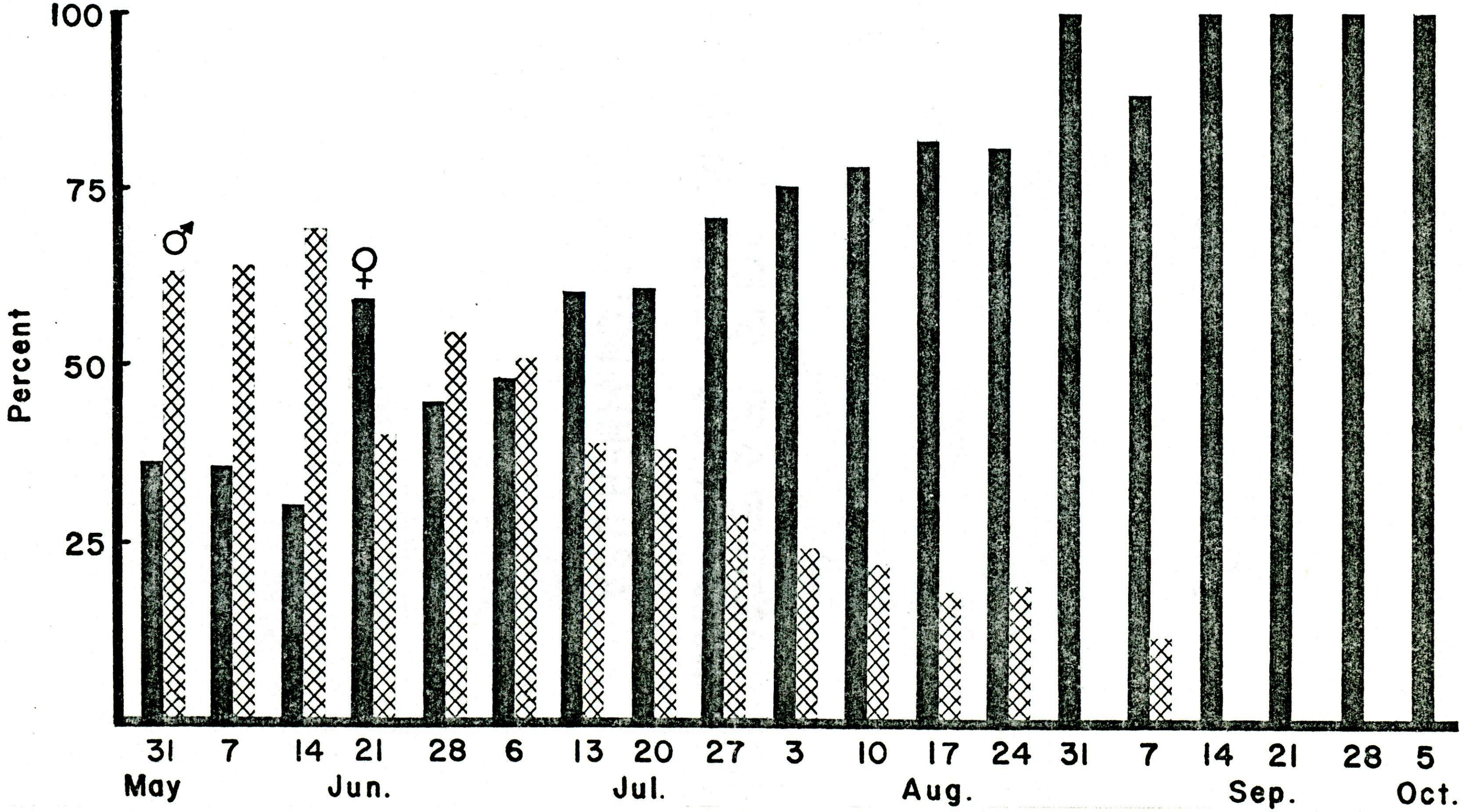
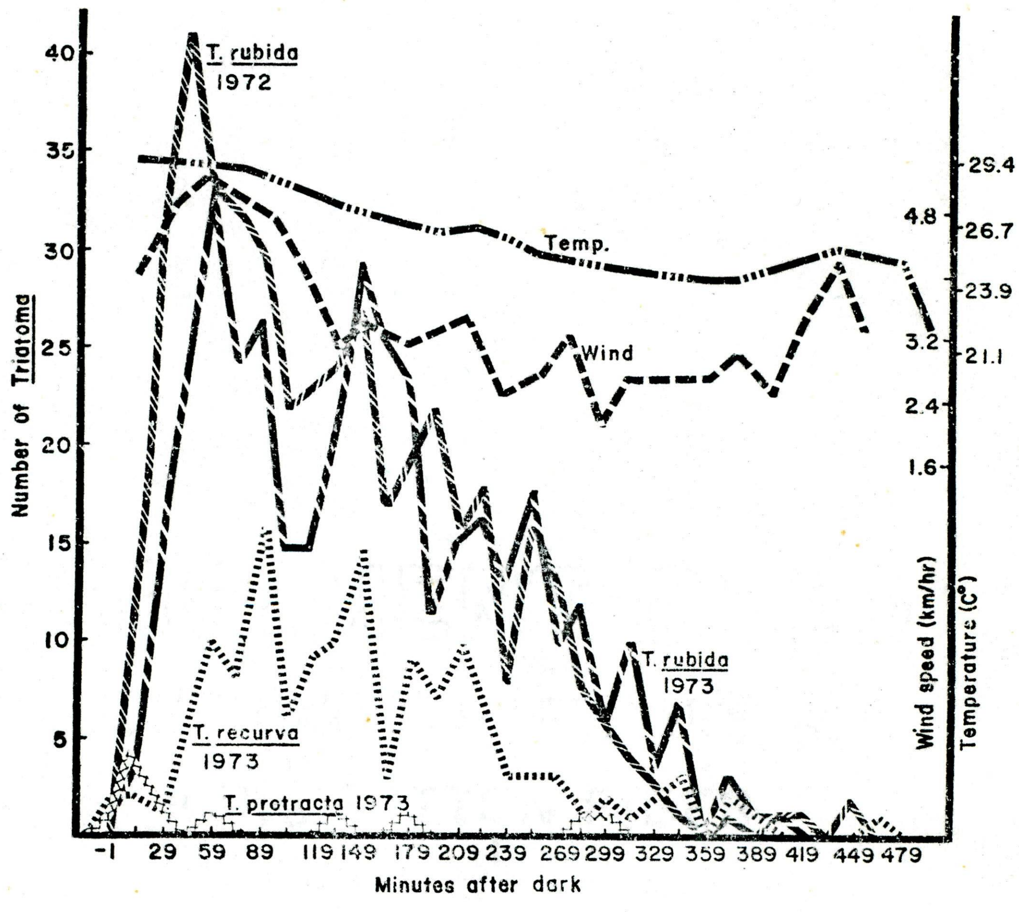

100
75
50
25
Percent
♂
♀
31 7 14 21 28 6 13 20 27 3 10 17 24 31 7 14 21 28 5
May Jun. Jul. Aug. Sep. Oct.

Figure 7. Number of Triatominae collected per 15-minute periods in relation to zero footcandles of light.



T. rubida 1972
Temp.
Wind
T. rubida 1973
T. recurva 1973
T. protracta 1973
Number of Triatoma
40
35
30
25
20
15
10
5
29.4
26.7
23.9
21.1
4.8
3.2
2.4
1.6
Wind speed (km/hr)
Temperature (C°)
-1 29 59 89 119 149 179 209 239 269 299 329 359 389 419 449 479
Minutes after dark

Figure 8. _Triatoma_ spp. collected per hour compared to moonlight expressed as a percentage of a full moon.

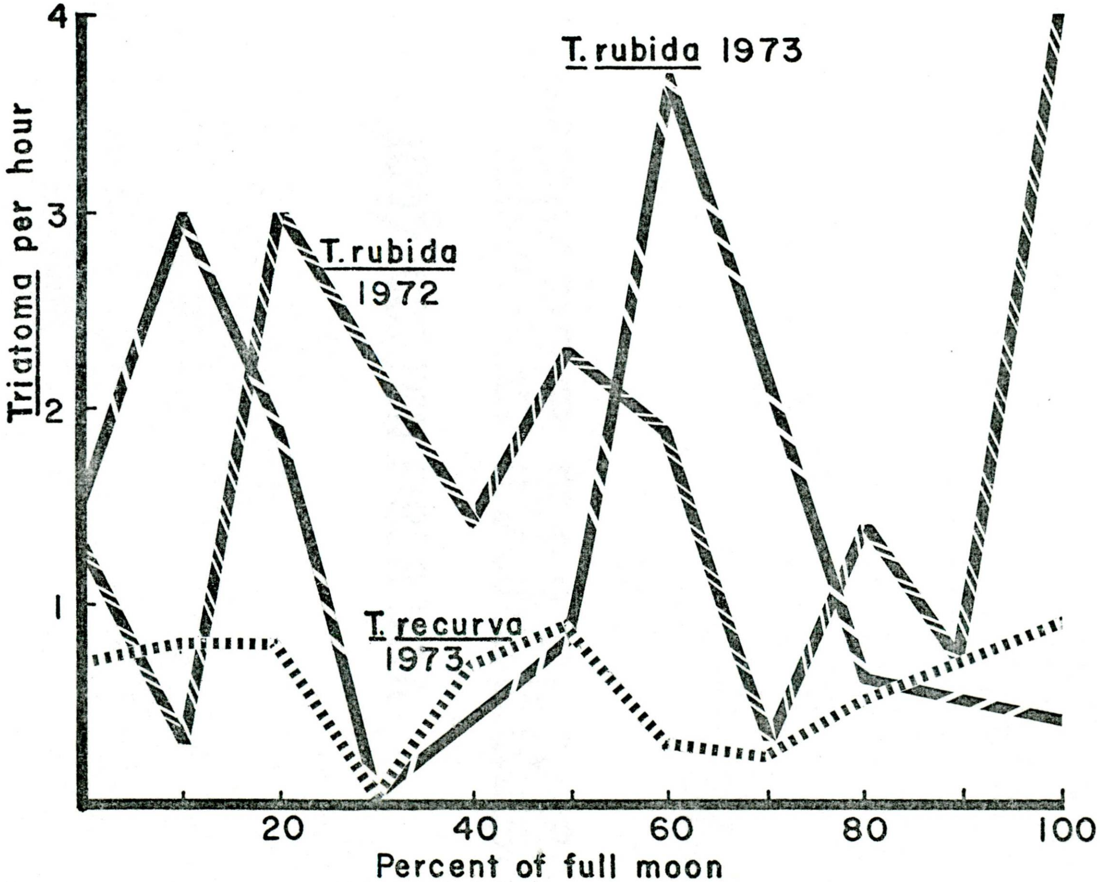
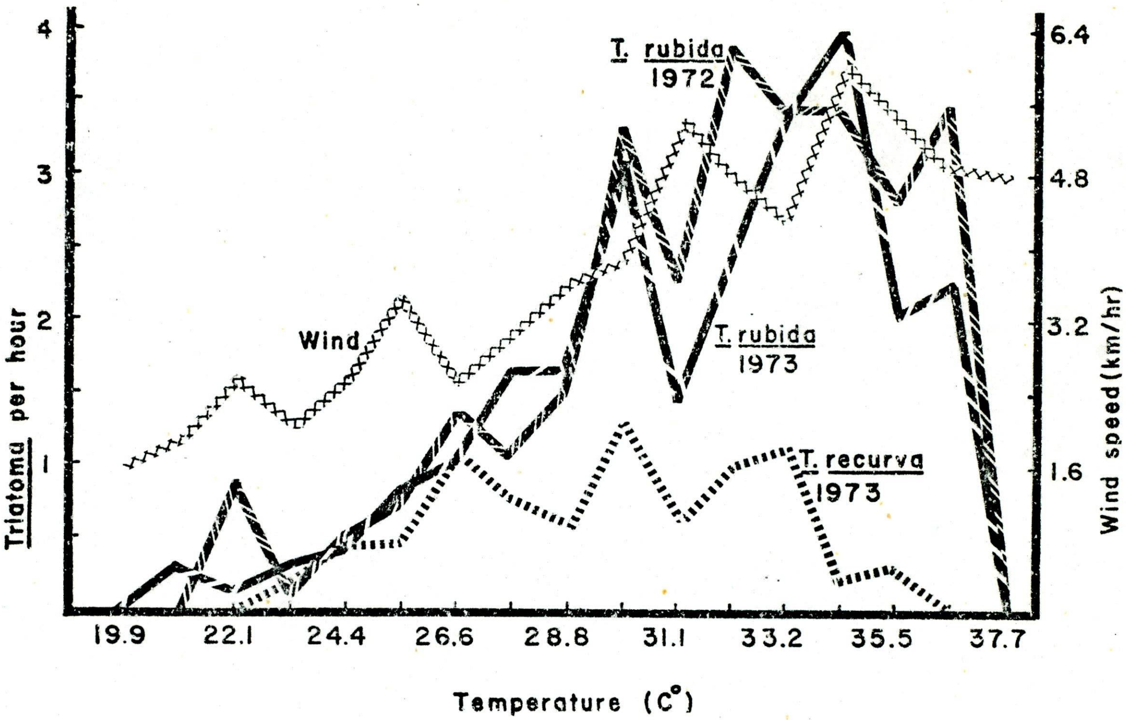
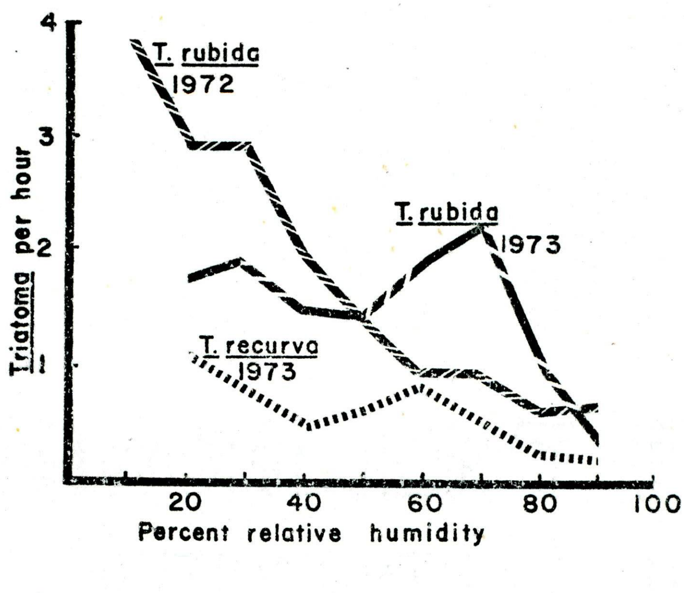

T. rubida 1973
T. rubida
1972
T. recurva
1973
Triatoma per hour
4
3
2
1
20
40
60
80
100
Percent of full moon

Figure 9. Number of Triatoma spp. collected per hour at indicated temperatures. Mean wind velocity is shown for each temperature.

Figure 10. Number of Triatoma spp. collected per hour at indicated relative humidities.



4
3
2
1
Triatoma per hour
T. rubida
1972
T. rubida
1973
T. recurva
1973
Wind
6.4
4.8
3.2
1.6
Wind speed (km/hr)
19.9
22.1
24.4
26.6
28.8
31.1
33.2
35.5
37.7
Temperature (C°)



4
3
2
1
Triatoma per hour
T. rubida
1972
T. rubida
1973
T. recurva
1973
20
40
60
80
100
Percent relative humidity

Figure 11. Number of *Triatoma* spp. collected per hour at indicated wind speeds.

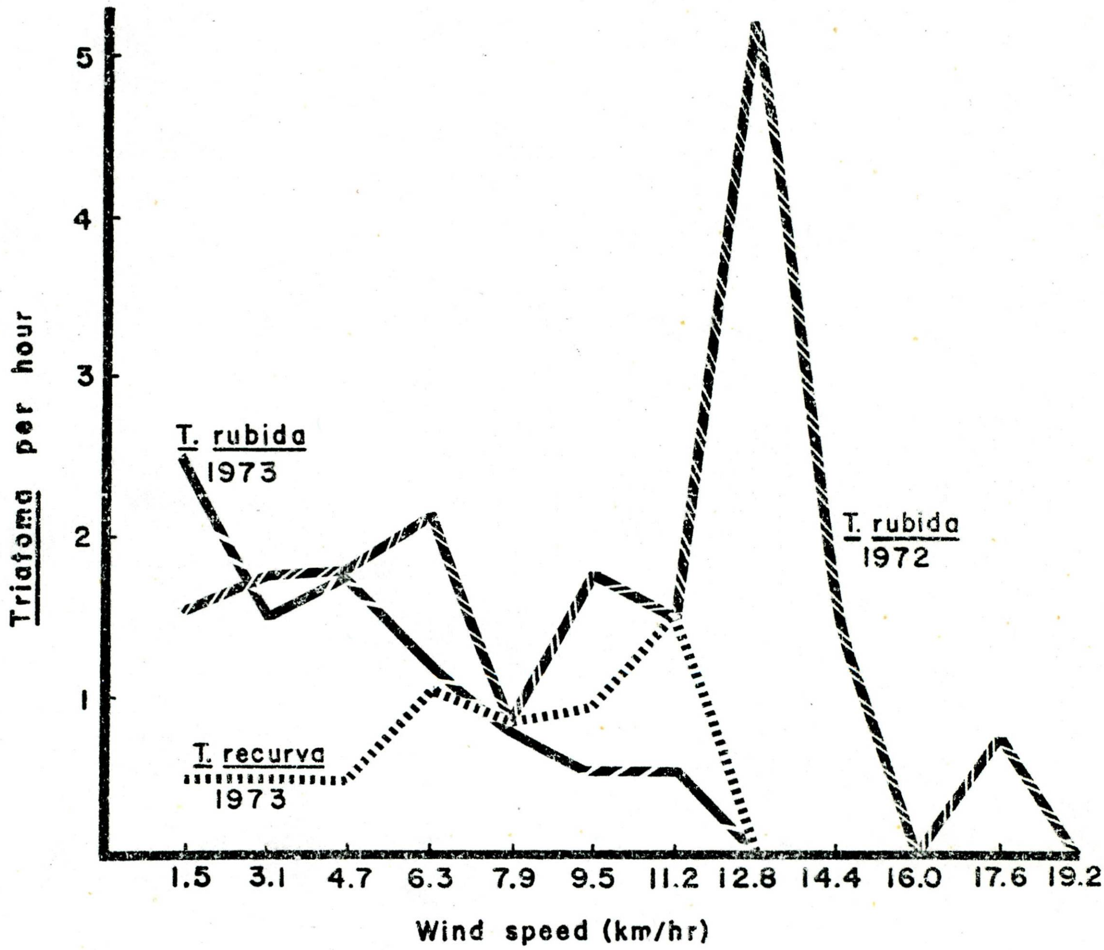
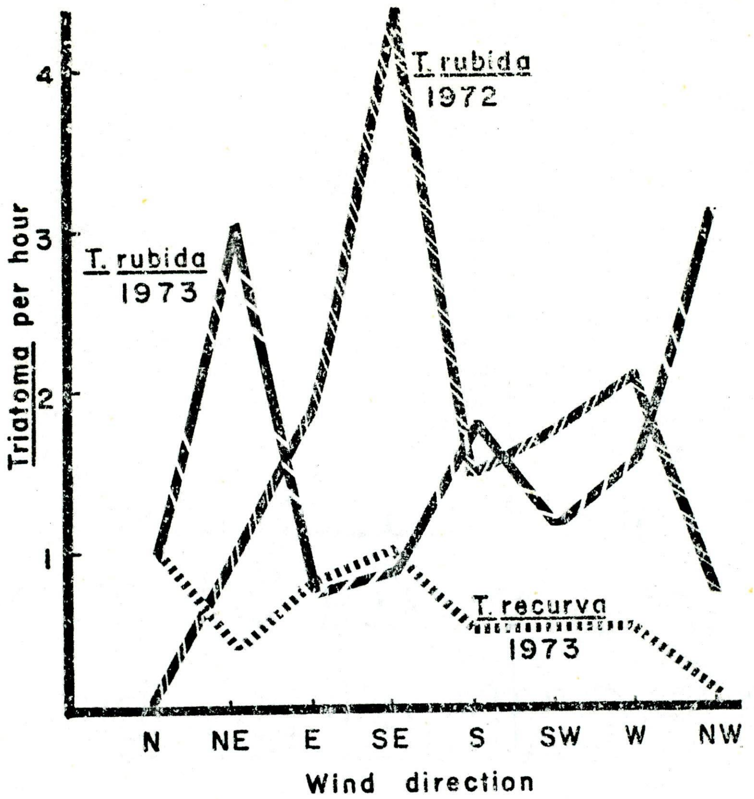

5
4
3
2
1
Triatoma per hour
T. rubida
1973
T. rubida
1972
T. recurva
1973
1.5
3.1
4.7
6.3
7.9
9.5
11.2
12.8
14.4
16.0
17.6
19.2
Wind speed (km/hr)

Figure 12. Number of _Triatoma_ spp. collected per hour at indicated wind direction.

Figure 13. Number of _Triatoma_ spp. collected per hour at indicated amounts of cloud cover.


T. rubida
1972
T. rubida
1973
T. recurva
1973
Triatoma per hour
1
2
3
4
N
NE
E
SE
S
SW
W
NW
Wind direction

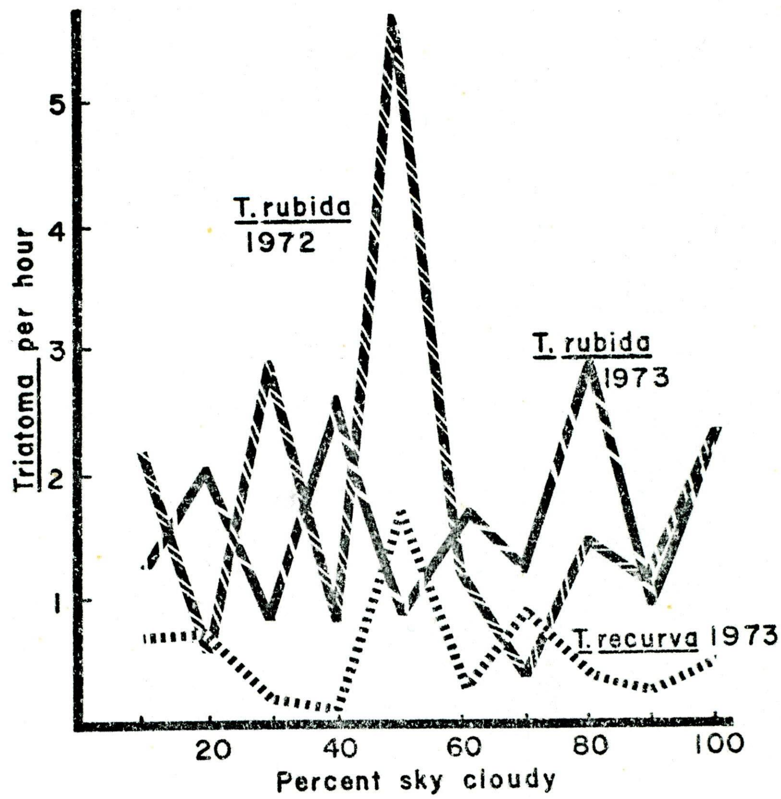

T. rubida
1972
T. rubida
1973
T. recurva 1973
Triatoma per hour
1
2
3
4
5
20
40
60
80
100
Percent sky cloudy

Figure 14. Average number of *Triatoma rubida uhleri* per night compared to total precipitation for each week, 1972.

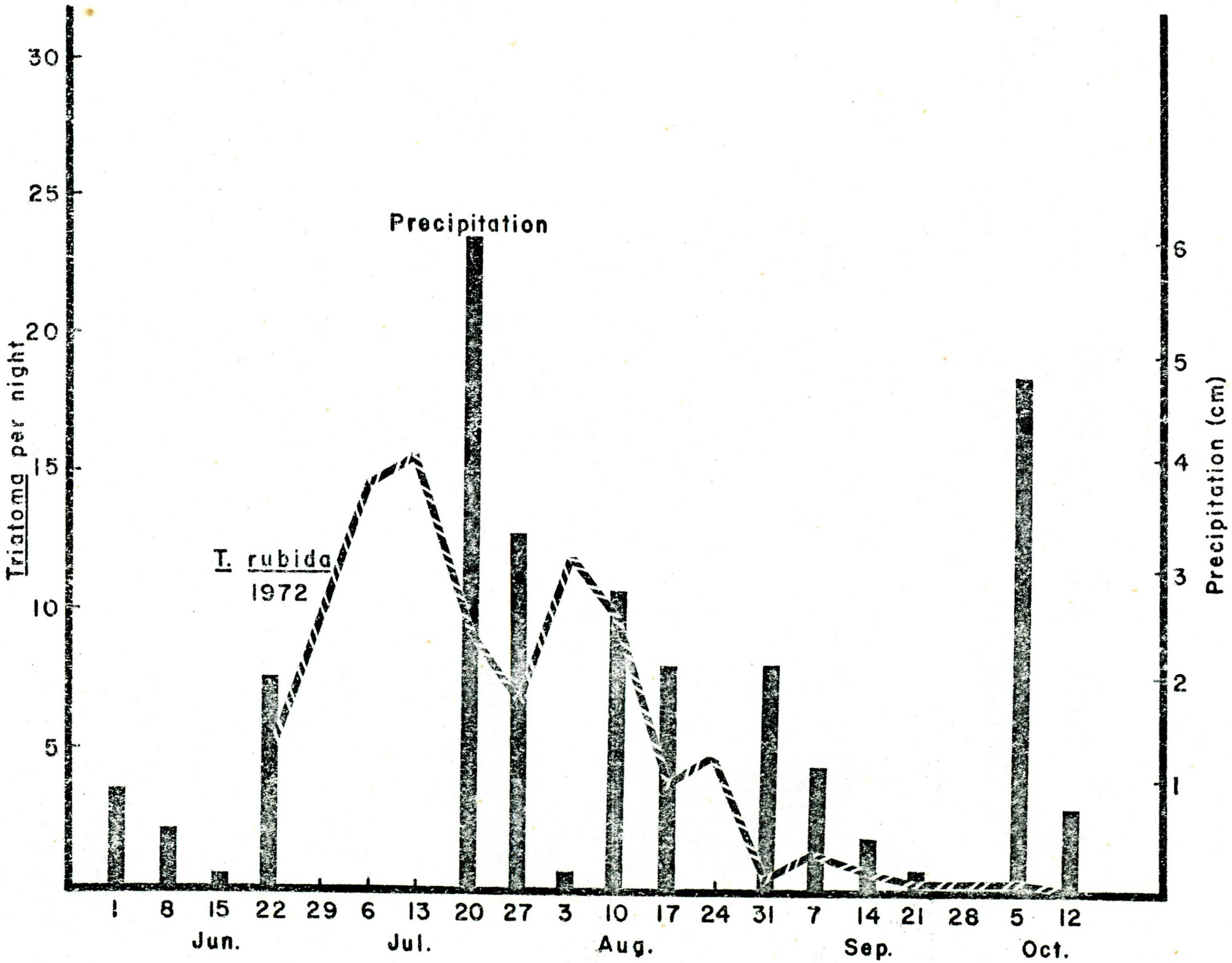
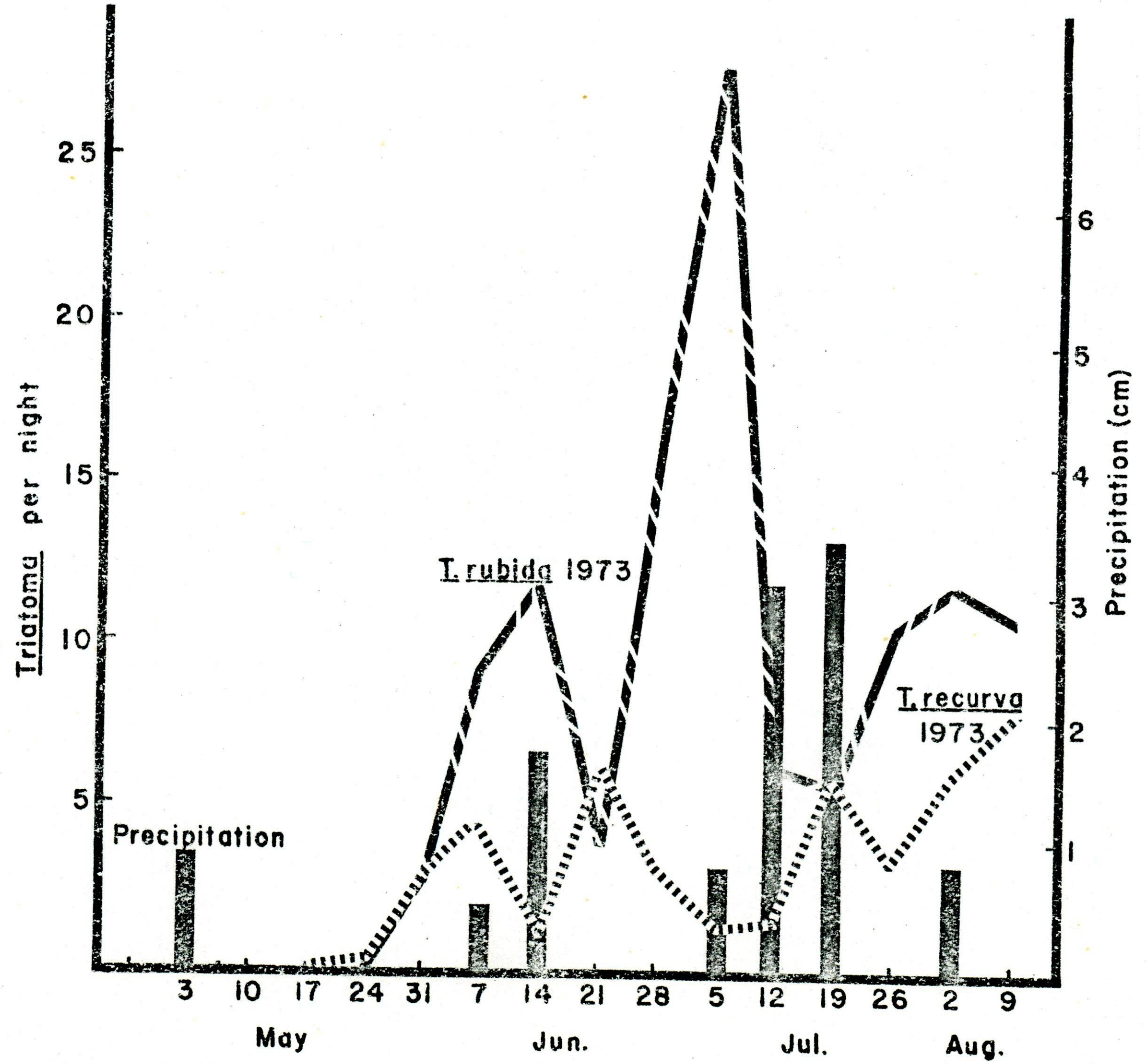

Precipitation
T. rubida
1972
Triatoma per night
Precipitation (cm)
30
25
20
15
10
5
6
5
4
3
2
1
1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12
Jun.
Jul.
Aug.
Sep.
Oct.

Figure 15. Average number of _Triatoma_ spp. per night compared to total precipitation for each week, 1973.



T. rubida 1973
T. recurva 1973
Precipitation
Triatoma per night
Precipitation (cm)
25
20
15
10
5
6
5
4
3
2
1
3 10 17 24 31 7 14 21 28 5 12 19 26 2 9
May
Jun.
Jul.
Aug.

Figure 16. Effect of mean night temperature on number of _Triatoma rubida uhleri_ collected per night, 1972.

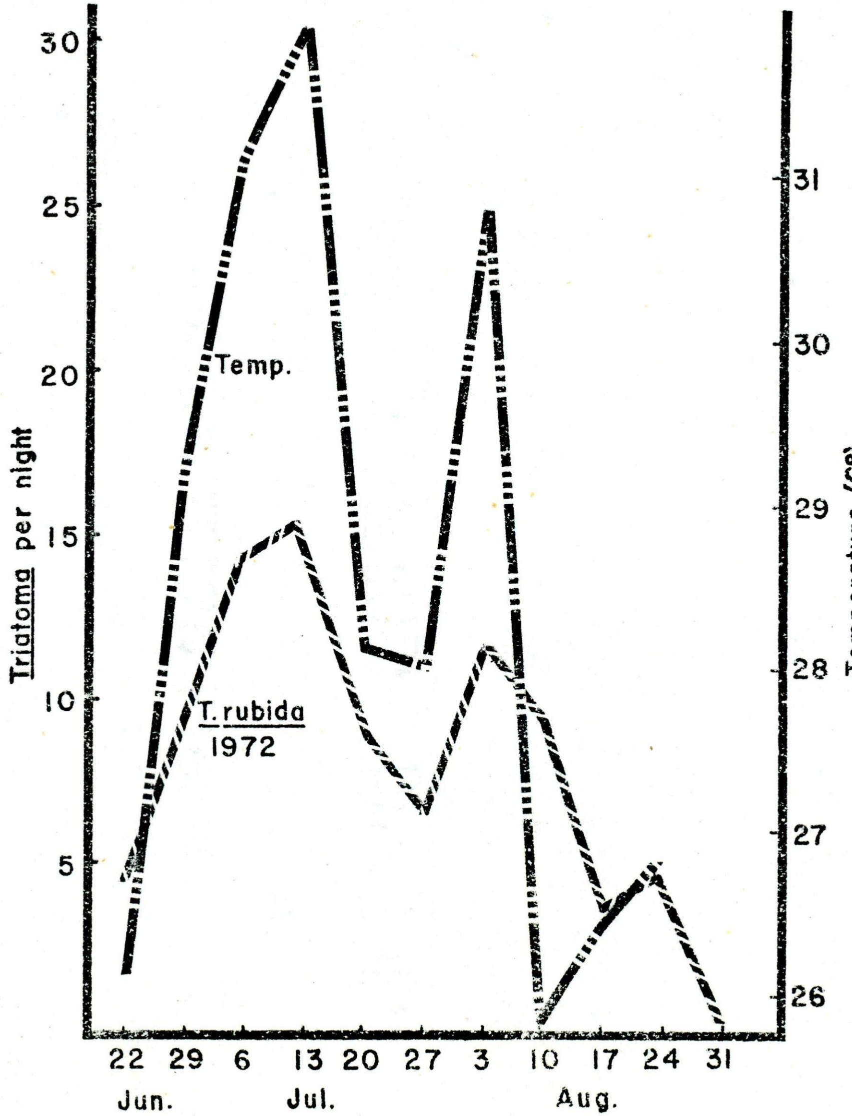

Triatoma per night
30
25
20
15
10
5
Temp.
T. rubida
1972
Temperature (C°)
31
30
29
28
27
26
22 29 6 13 20 27 3 10 17 24 31
Jun.
Jul.
Aug.

Figure 17. Effect of mean night temperature and relative humidity on the number of *Triatoma* spp. collected per night, 1973.

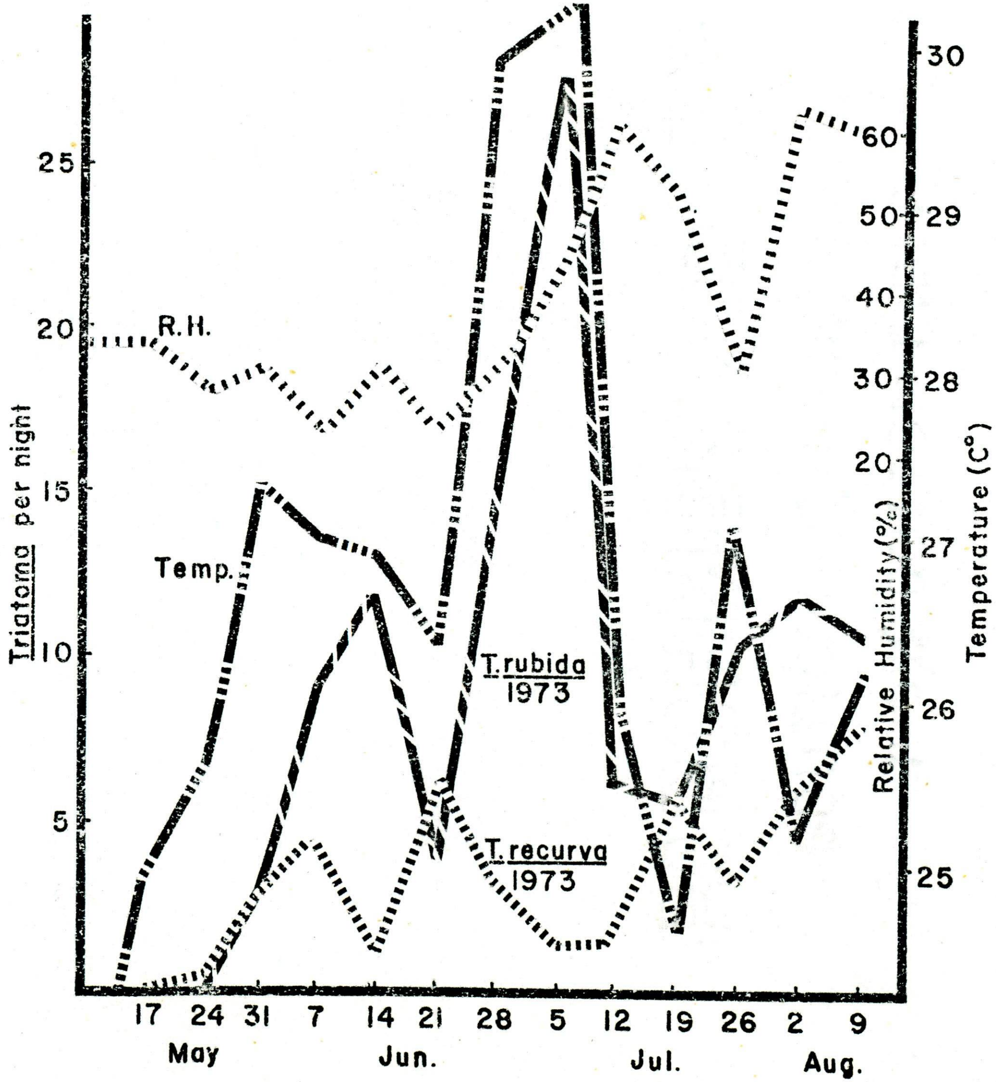
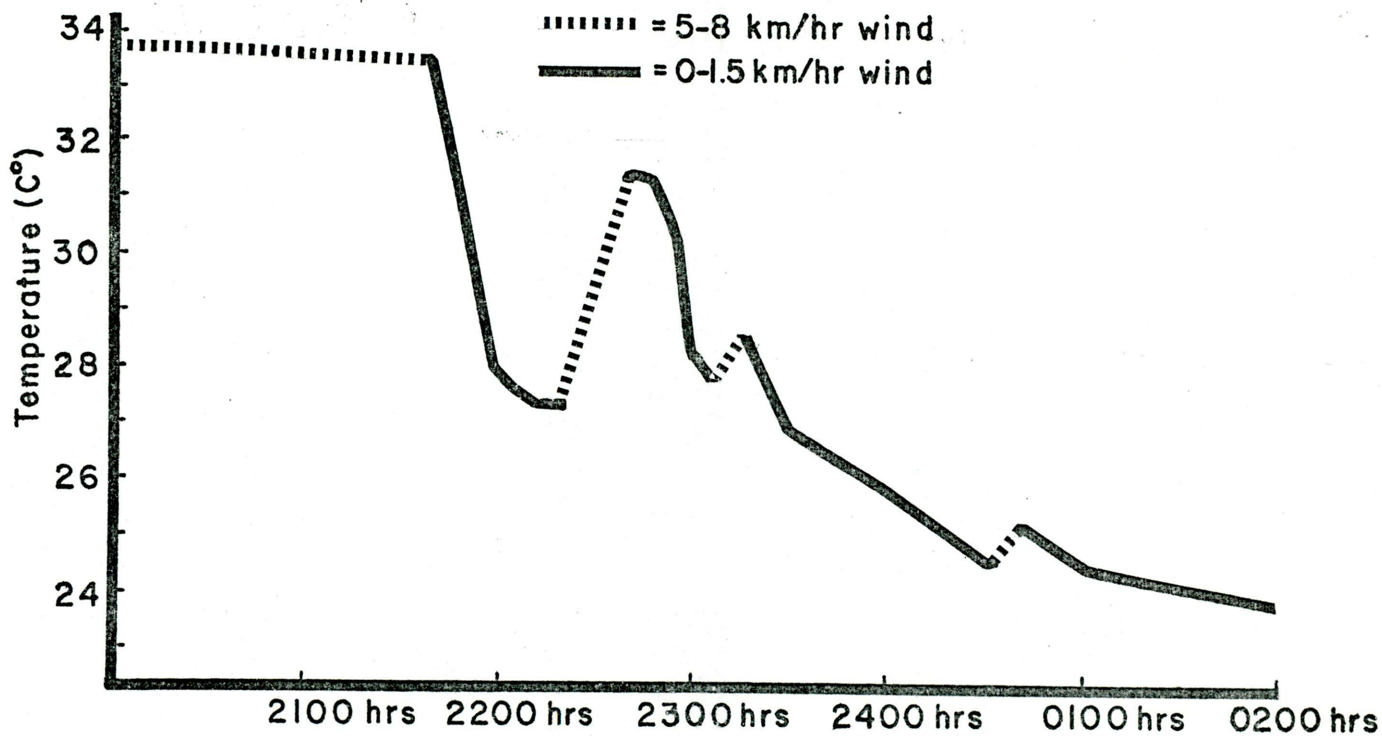

R.H.
Temp.
T. rubida
1973
T. recurva
1973
Triatoma per night
25
20
15
10
5
60
50
40
30
20
Relative Humidity (%)
30
29
28
27
26
25
Temperature (C°)
17
24
31
7
14
21
28
5
12
19
26
2
9
May
Jun.
Jul.
Aug.

Figure 18. Hygrothermograph trace of centigrade temperature of 7 June 1973, showing the effect of the wind on the temperature.



= 5-8 km/hr wind
= 0-1.5 km/hr wind
Temperature (C°)
34
32
30
28
26
24
2100 hrs
2200 hrs
2300 hrs
2400 hrs
0100 hrs
0200 hrs

Figure 19. Mean rate of weight loss of 23 _Triatoma rubida_ females with confidence intervals for days from blood meal to death.

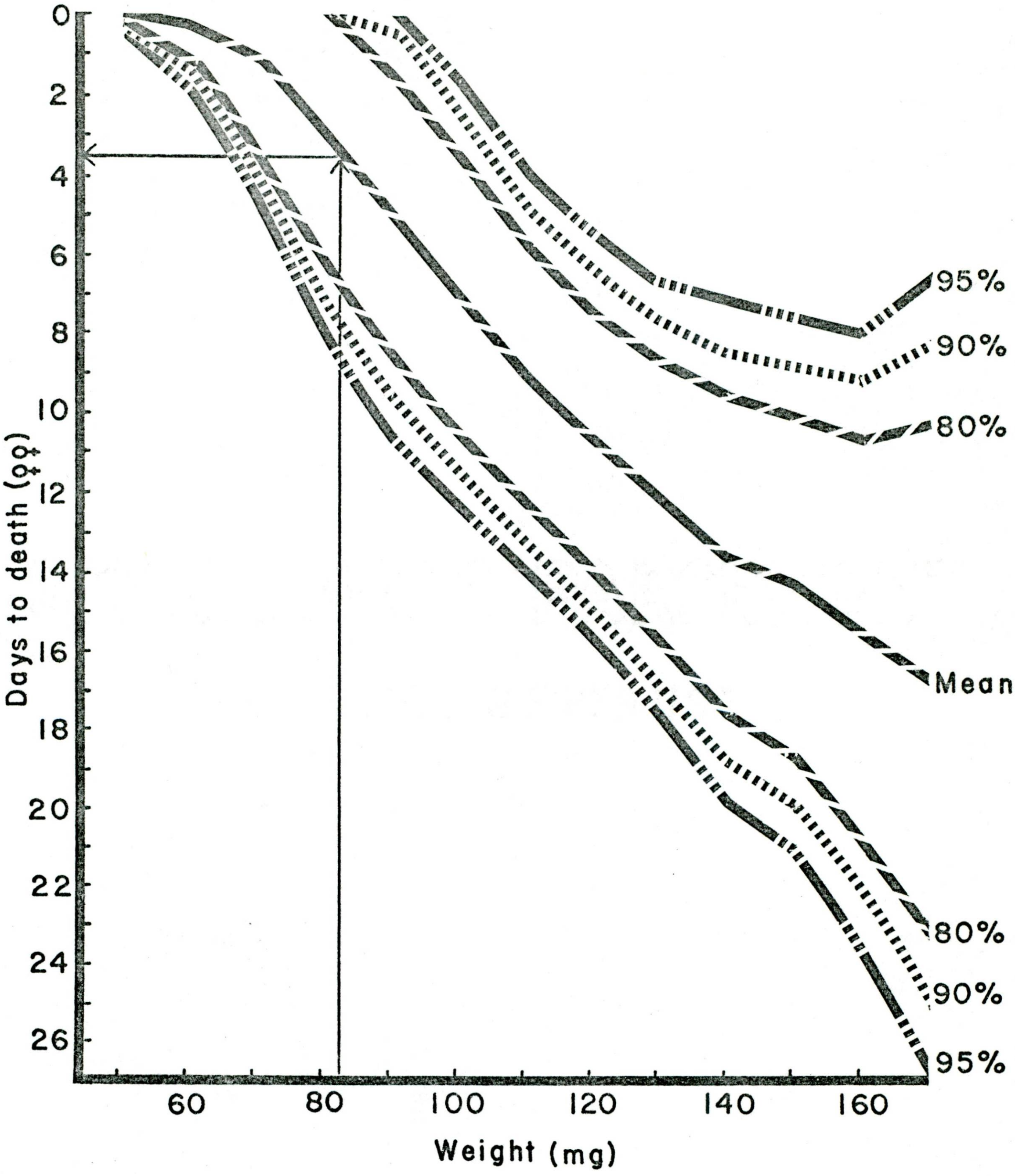
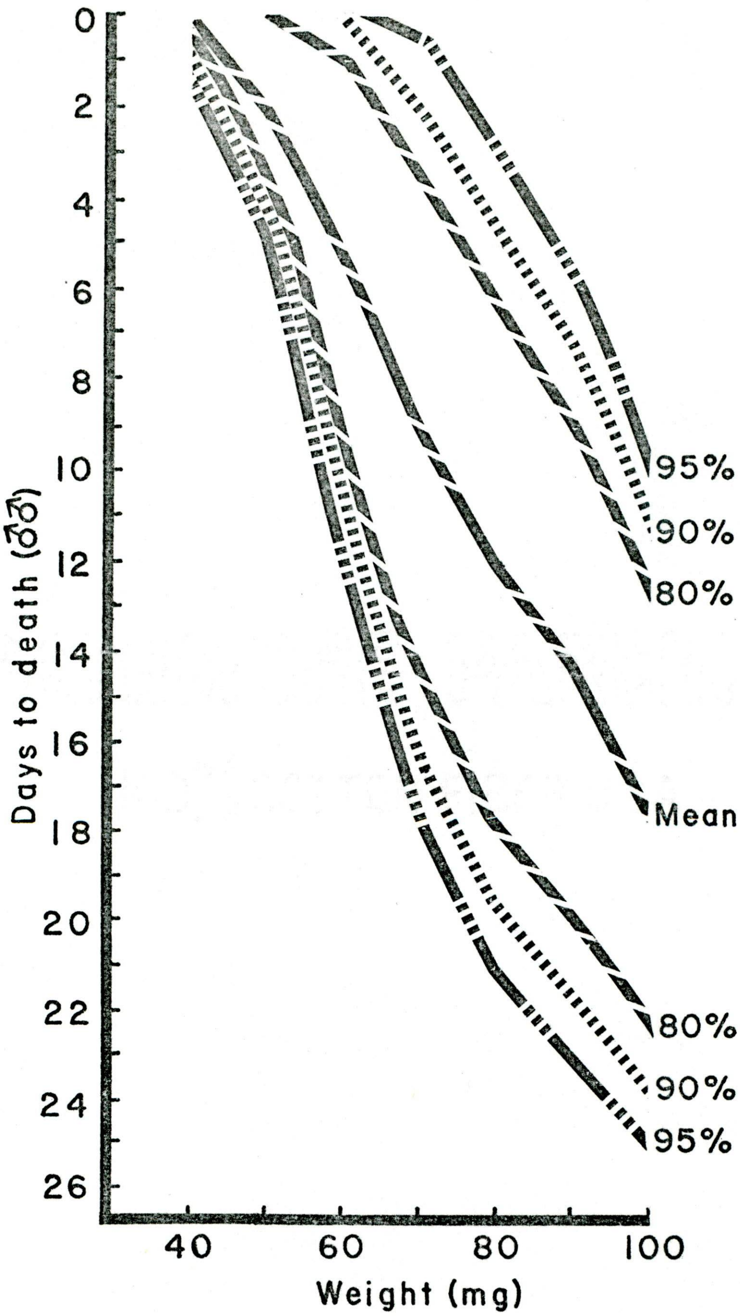

Days to death (♀♀)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
60
80
100
120
140
160
Weight (mg)
95%
90%
80%
Mean
80%
90%
95%

Figure 20. Mean rate of weight loss of 22 *Triatoma rubida* males with confidence intervals for days from blood meal to death.



Days to death (♂♂)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
40
60
80
100
Weight (mg)
95%
90%
80%
Mean
80%
90%
95%

TABLE 1. Precipitation (cm) in Sabino Canyon, Arizona. Twenty-nine year mean, and 1972 and 1973 records.

Month	29-year Mean	1972	1973
January	2.54	0	0.25
February	1.98	0	5.74
March	2.29	0.03	7.26
April	1.19	0	0.15
May	0.28	0.81	0.91
June	0.51	3.81	2.18
July	4.95	10.06	8.33
August	6.60	5.51	2.95
September	3.02	3.94	0.08
October	2.21	13.31	0.0
November	1.68	3.38	1.78
December	3.00	2.21	0.0
Total	30.25	43.06	29.63

Table 2. Collections of Triatominae in Sabino Canyon, Arizona, at lights and traps.

	1972	1973
Triatoma rubida uhleri		
Old House light (Adults)	488	377
Old House light (Nymphs)	1	0
Stikem traps	3	0
Entrance Station	7	0
Entrance Station trap	10	0
Lower Sabino light	4	0
Picnic area	13	1
Phone booth	2	0
Upper road light	3	0
Visitor's Center	2	0
Roser's house	3	0
Total	536	378
T. recurva		
Old House light (Adults)	29	141
Old House light (Nymphs)	4	1
Entrance Station	1	0
Picnic area	1	0
Total	35	142

Table 2. Continued

	1972	1973
T. protracta protracta		
Old House light	7	10
Entrance Station	1	0
Entrance Station trap	2	0
Lower Sabino trap	1	0
Picnic area	0	1
Total	11	11
Total Triatominae	582	531

Table 3. Sex ratios by week of *Triatoma rubida uhleri*. Weeks 21 June through 10 August include data from 1972 and 1973.

Week Ending	Females	Males	Ratio Female:Male
May 31	4	7	1.0 :1.75
Jun. 7	17	30	1.0 :1.77
14	11	25	1.0 :2.75
21	19	13	1.46:1.0
28	54	66	1.0 :1.22
Jul. 6	63	67	1.0 :1.06
13	74	48	1.54:1.0
20	40	25	1.6 :1.0
27	47	19	2.47:1.0
Aug. 3	75	24	3.13:1.0
10	50	14	3.57:1.0
17	18	4	4.5 :1.0
24	26	6	4.33:1.0
31	2	0	2.0 :0.0
Sep. 7	8	1	8.0 :1.0
14	3	0	3.0 :0.0
21	1	0	1.0 :0.0
28	1	0	1.0 :0.0
Oct. 5	1	0	1.0 :0.0

Table 4. Effect of moonlight on flights of Triatoma spp. in Sabino Canyon, Arizona. Hours indicated are actual collection times.

Percent of Full Moon	Hours		Percent of Time		T. rubida						T. recurva						T. protracta					
	1972	1973	1972	1973	1972			1973			1972			1973			1972			1973		
					Total	Percent	Bugs per hour	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour
0	246.5	162.3	70.9	71.1	330	68.2	1.3	254	74.7	1.6	16	55.2	0.06	105	73.4	0.7	6	85.7	0.02	5	55.5	0.03
1 - 10	4.0	1.3	1.2	0.6	1	0.2	0.3	4	1.2	3.0	0	0	0	1	0.7	0.8	0	0	0	0	0	0
11 - 20	1.0	2.7	0.3	1.2	3	0.6	3.0	5	1.5	1.9	0	0	0	2	1.4	0.8	0	0	0	0	0	0
21 - 30	5.3	2.7	1.5	1.2	12	2.5	2.2	0	0	0	1	3.4	0.19	0	0	0	0	0	0	1	11.1	0.37
31 - 40	3.5	7.0	1.0	3.1	5	1.0	1.4	3	0.9	0.4	1	3.4	0.28	5	3.5	0.7	0	0	0	1	11.1	0.14
41 - 50	12.0	6.7	3.5	2.9	27	5.6	2.3	12	3.5	1.8	2	6.9	0.17	6	4.2	0.9	0	0	0	1	11.1	0.15
51 - 60	11.0	7.3	3.2	3.2	21	4.3	1.9	27	7.9	3.7	1	3.4	0.09	2	1.4	0.3	0	0	0	0	0	0
61 - 70	10.5	8.7	3.0	3.8	3	0.6	0.3	20	5.9	2.3	0	0	0	2	1.4	0.2	0	0	0	0	0	0
71 - 80	31.0	13.3	8.9	5.8	42	8.7	1.4	8	2.4	0.6	2	6.9	0.06	6	4.2	0.5	0	0	0	1	11.1	0.07
81 - 90	15.5	5.7	4.4	2.5	10	2.1	0.7	3	0.9	0.5	0	0	0	4	2.8	0.7	1	14.3	0.06	0	0	0
91 -100	7.3	10.7	2.1	4.7	30	6.2	4.1	4	1.2	0.4	6	20.7	0.8	10	7.0	0.9	0	0	0	0	0	0

Table 5. Effect of temperature on the flights of <u>Triatoma</u> spp. in Sabino Canyon, Arizona. Hours indicated are actual collection times.

	Hours		Percent of Time		T. rubida						T. recurva						T. protracta					
					1972			1973			1972			1973			1972			1973		
Temperature (C°)	1972	1973	1972	1973	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour
15.6 - 16.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.7 - 17.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.8 - 18.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.9 - 19.9	0.3	0.7	0.1	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.0 - 21.0	1.7	5.7	0.7	2.5	0	0	0	2	0.6	0.4	0	0	0	0	0	0	0	0	0	0	0	0
21.1 - 22.1	2.3	12.3	1.0	5.4	2	0.4	0.9	2	0.6	0.2	0	0	0	0	0	0	0	0	0	1	10	0.08
22.2 - 23.2	9.7	19.7	4.0	8.6	1	0.2	0.1	7	2.1	0.4	1	3.4	0.1	5	3.5	0.3	0	0	0	0	0	0
23.4 - 24.4	11.7	18.3	4.8	8.0	6	1.3	0.5	8	2.4	0.4	0	0	0	8	5.6	0.4	0	0	0	0	0	0
24.5 - 25.5	20.0	25.3	8.3	11.1	14	3.0	0.7	21	6.2	0.8	1	3.4	0.05	12	8.4	0.5	0	0	0	0	0	0
25.6 - 26.6	28.7	22.7	11.8	9.9	39	8.3	1.4	23	6.8	1.0	1	3.4	0.03	25	17.5	1.1	1	14.3	0.03	3	30	0.13
26.7 - 27.7	29.0	23.7	12.0	10.4	31	6.6	1.1	39	11.5	1.7	1	3.4	0.03	18	12.6	0.8	1	14.3	0.03	0	0	0
27.8 - 28.8	33.7	27.3	13.9	12.0	51	10.9	1.5	44	13.0	1.6	7	24.1	0.21	15	10.5	0.6	1	14.3	0.03	2	20	0.09
28.9 - 29.9	22.3	17.7	9.2	7.7	73	15.6	3.3	54	16.0	3.1	5	17.2	0.22	22	15.4	1.3	0	0	0	1	10	0.06
30.0 - 31.0	33.0	14.3	13.6	6.3	75	16.0	2.3	21	6.2	1.5	6	20.7	0.18	9	6.3	0.6	0	0	0	0	0	0
31.1 - 32.1	18.3	14.0	7.6	6.1	70	15.0	3.8	34	10.1	2.4	4	13.8	0.22	14	9.8	1.0	2	28.6	0.11	1	10	0.07
32.2 - 33.2	12.7	10.0	5.2	4.4	43	9.2	3.4	34	10.1	3.4	2	6.9	0.16	11	7.7	1.1	0	0	0	1	10	0.1
33.4 - 34.4	11.3	8.3	4.7	3.7	39	8.3	3.4	33	9.8	4.0	1	3.4	0.09	2	1.4	0.2	0	0	0	0	0	0
34.5 - 35.5	5.3	6.3	2.2	2.8	15	3.2	2.8	13	3.9	2.1	0	0	0	2	1.4	0.3	2	28.6	0.38	0	0	0
35.6 - 36.6	2.3	1.3	1.0	0.6	8	1.7	3.4	3	0.9	2.3	0	0	0	0	0	0	0	0	0	1	10	0.76
36.7 - 37.7	0	0.3	0	0.2	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0

Table 6. Effect of relative humidity on the flights of *Triatoma* spp. in Sabino Canyon, Arizona. Hours indicated are actual collection times.

Percent Relative Humidity	Hours		Percent of Time		*T. rubida*						*T. recurva*						*T. protracta*					
					1972			1973			1972			1973			1972			1973		
	1972	1973	1972	1973	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour
1 - 10	3.7	0	1.6	0	14	2.9	3.8	0	0	0	4	13.8	1.1	0	0	0	0	0	0	0	0	0
11 - 20	24.0	26.3	10.4	11.5	69	14.3	2.9	47	13.8	1.8	7	24.1	0.29	28	19.6	1.1	0	0	0	3	30	0.1
21 - 30	40.7	78.0	17.6	34.2	118	24.4	2.9	147	43.2	1.9	2	6.9	0.05	56	39.2	0.7	5	71.4	0.1	3	30	0.04
31 - 40	79.3	39.3	34.3	17.2	154	31.9	1.9	58	17.1	1.5	6	20.7	0.07	18	12.6	0.5	0	0	0	2	20	0.05
41 - 50	39.7	35.0	17.2	15.3	54	11.2	1.4	49	14.4	1.4	6	20.7	0.15	19	13.3	0.5	1	14.3	0.02	1	10	0.03
51 - 60	13.0	17.7	5.6	7.7	25	5.2	1.9	15	4.4	0.9	2	6.9	0.15	13	9.1	0.7	0	0	0	1	10	0.06
61 - 70	15.3	15.0	6.6	6.6	34	7.0	2.2	13	3.8	0.9	1	3.4	0.06	6	4.2	0.4	1	14.3	0.06	0	0	0
71 - 80	11.0	9.7	4.8	4.2	11	2.3	1.0	5	1.5	0.5	1	3.4	0.09	2	1.4	0.2	0	0	0	0	0	0
81 - 90	3.3	7.3	1.4	3.2	1	0.2	0.3	4	1.2	0.6	0	0	0	1	0.7	0.1	0	0	0	0	0	0
91 -100	1.0	0	0.4	0	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 7. Effect of wind speed on flights of Triatoma spp. in Sabino Canyon, Arizona. Hours indicated are actual collection times.

Wind Speed Km. per Hour	Hours 1972	Hours 1973	Percent of Time 1972	Percent of Time 1973	T. rubida 1972 Total	T. rubida 1972 Percent	T. rubida 1972 Bugs per hour	T. rubida 1973 Total	T. rubida 1973 Percent	T. rubida 1973 Bugs per hour	T. recurva 1972 Total	T. recurva 1972 Percent	T. recurva 1972 Bugs per hour	T. recurva 1973 Total	T. recurva 1973 Percent	T. recurva 1973 Bugs per hour	T. protracta 1972 Total	T. protracta 1972 Percent	T. protracta 1972 Bugs per hour	T. protracta 1973 Total	T. protracta 1973 Percent	T. protracta 1973 Bugs per hour
0 - 1.5	127.7	37.3	45.5	16.3	198	42.4	1.6	93	27.4	2.5	6	21.4	0.05	18	12.6	0.5	4	57.1	0.03	2	20	0.05
1.6 - 3.1	32.0	55.3	11.4	24.2	57	12.2	1.8	86	25.3	1.6	3	10.7	0.09	25	17.5	0.5	3	42.9	0.09	2	20	0.04
3.2 - 4.7	30.7	47.7	10.9	20.9	55	11.8	1.8	84	24.7	1.8	4	14.3	0.13	20	14.0	0.4	0	0	0	2	20	0.04
4.8 - 6.3	48.3	39.0	17.2	17.1	103	22.1	2.1	46	13.5	1.2	7	25.0	0.14	40	28.0	1.0	0	0	0	2	20	0.05
6.4 - 7.9	22.7	29.0	8.1	12.7	19	4.1	0.8	23	6.8	0.8	4	14.3	0.18	24	16.8	0.8	0	0	0	1	10	0.03
8.0 - 9.6	13.0	14.0	4.6	6.1	23	4.9	1.8	7	2.1	0.5	4	14.3	0.31	13	9.1	0.9	0	0	0	1	10	0.07
9.7-11.2	2.0	2.0	0.7	0.9	3	0.6	1.5	1	0.3	0.5	0	0	0	3	2.1	1.5	0	0	0	0	0	0
11.3-12.8	1.3	2.7	0.5	1.2	7	1.5	5.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.9-14.4	0.7	0.7	0.2	0.3	1	0.2	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.5-16.0	0.3	0.0	0.1	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.1-17.6	1.3	1.0	0.5	0.4	1	0.2	0.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.7-19.2	0.3	0.0	0.1	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19.3-20.8	0	0.0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.9-22.4	0	0.0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22.5-24.0	0	0.0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 8. Effect of wind direction on flights of Triatoma spp. in Sabino Canyon, Arizona. Hours indicated are actual collection times.

Wind Direction	Hours 1972	Hours 1973	Percent of Time 1972	Percent of Time 1973	*T. rubida* 1972 Total	*T. rubida* 1972 Percent	*T. rubida* 1972 Bugs per hour	*T. rubida* 1973 Total	*T. rubida* 1973 Percent	*T. rubida* 1973 Bugs per hour	*T. recurva* 1972 Total	*T. recurva* 1972 Percent	*T. recurva* 1972 Bugs per hour	*T. recurva* 1973 Total	*T. recurva* 1973 Percent	*T. recurva* 1973 Bugs per hour	*T. protracta* 1972 Total	*T. protracta* 1972 Percent	*T. protracta* 1972 Bugs per hour	*T. protracta* 1973 Total	*T. protracta* 1973 Percent	*T. protracta* 1973 Bugs per hour
North	1.0	2.0	0.7	1.0	0	0.0	0.0	2	0.8	1.0	0	0	0	2.0	1.6	1.0	0	0	0	1	12.5	0.5
North East	13.0	5.0	8.5	2.5	12	4.2	0.9	15	6.0	3.0	0	0	0	2.0	1.6	0.4	0	0	0	0	0	0
East	92.7	70.3	60.3	35.6	174	61.1	1.9	55	22.0	0.8	18	78.3	0.2	56.0	43.4	0.8	1	25	0.01	4	50.0	0.06
South East	2.3	17.7	1.5	8.9	10	3.5	4.4	16	6.4	0.9	1	4.3	0.4	19.0	14.7	1.1	0	0	0	0	0	0
South	4.0	6.0	2.6	3.0	6	2.1	1.5	11	4.4	1.8	0	0	0	3.0	2.3	0.5	0	0	0	2	25.0	0.33
South West	1.7	31.3	1.1	15.9	2	0.7	1.2	38	15.2	1.2	0	0	0	16.0	12.4	0.5	1	25	0.59	1	12.5	0.03
West	37.7	58.0	24.5	29.3	80	28.1	2.1	90	36.0	1.6	4	17.4	0.1	30.0	23.3	0.5	2	50	0.05	0	0	0
North West	1.3	7.3	0.9	3.7	1	0.4	0.8	23	9.2	3.2	0	0	0	1.0	0.8	0.1	0	0	0	0	0	0

Table 9. Effect of cloud cover on flights of Triatoma spp. in Sabino Canyon, Arizona. Hours indicated are actual collection times.

Percent of Sky Cloudy	Hours		Percent of Time		*T. rubida*						*T. recurva*						*T. protracta*					
					1972			1973			1972			1973			1972			1973		
	1972	1973	1972	1973	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour	Total	Percent	Bugs per hour
0	116	112.3	53.6	49.1	222	47.5	1.9	135	39.7	1.2	21	72.4	0.18	71	49.7	0.6	2	28.6	0.02	5	50	0.04
1 - 10	21.0	33.3	9.7	14.6	77	16.5	3.7	48	14.1	1.4	3	10.3	0.14	32	22.4	1.0	2	28.6	0.09	2	20	0.06
11 - 20	3.3	17.3	1.5	7.6	2	0.4	0.6	36	10.6	2.1	1	3.4	0.30	12	8.4	0.7	0	0	0	0	0	0
21 - 30	20.0	9.3	9.3	4.1	58	12.4	2.9	8	2.4	0.9	3	10.3	0.15	2	1.4	0.2	0	0	0	0	0	0
31 - 40	2.3	7.0	1.1	3.1	2	0.4	0.9	18	5.3	2.6	0	0	0	1	0.7	0.1	0	0	0	1	10	0.14
41 - 50	4.3	2.3	2.0	1.0	24	5.1	5.5	2	0.6	0.9	0	0	0	4	2.8	1.7	0	0	0	0	0	0
51 - 60	5.0	6.7	2.3	2.9	6	1.3	1.2	11	3.2	1.7	0	0	0	2	1.4	0.3	0	0	0	0	0	0
61 - 70	5.0	4.7	2.3	2.0	2	0.4	0.4	6	1.8	1.3	0	0	0	4	2.8	0.9	0	0	0	1	10	0.21
71 - 80	11.7	7.7	5.4	3.4	17	3.6	1.5	22	6.5	2.9	0	0	0	3	2.1	0.4	0	0	0	0	0	0
81 - 90	4.3	8.3	2.0	3.6	5	1.1	1.2	8	2.4	1.0	1	3.4	0.23	2	1.4	0.2	2	28.6	0.46	0	0	0
91 - 100	23.3	19.7	10.8	8.6	52	11.1	2.2	46	13.5	2.3	0	0	0	10	7.0	0.5	1	14.3	0.04	1	10	0.05

Table 10. Days that rain fell in summers of 1972 and 1973 in Sabino Canyon. The number of bugs caught each evening and the average per night for that week are also indicated.

Days of Precipitation Date 1972		Bugs Collected on Rainy Nights	Average Number of Bugs per Night per Week
Jun.	21	0	5
	22	5	5
Jul.	10	4	16
	15	10	9.5
	17	7	9.5
	22	4	7
	23	6	7
	27	3	7
Aug.	6	18	10
	7	17	10
	8	3	10
	19	3	5
	26	0	0.5
	28	1	0.5
	29	0	0.5
	31	0	0.5

Table 10 (cont.) Days that rain fell in summers of 1972 and 1973 in Sabino Canyon. The number of bugs caught each each evening and the average per night for that week are also indicated

Days of Precipitation Date 1972	Bugs Collected on Rainy Nights	Average Number of Bugs per Night per Week
Sep. 5	0	1.5
12	2	0.7
17	0	0.17
Oct. 3	0	0.33
4	0	0.33
Date 1973		
Jul. 1	19	28.33
3	53	28.33
8	0	6.25
9	15	6.25
12	3	6.25
16	5	5.67
17	4	5.67
29	7	12.0

Table 11. Results of Step-wise Regression test, indicating the physical factor most highly correlated with number of bugs, its correlation coefficient (R), pairs of physical factors which are correlated and their R values and a list of the physical factors which were added and the multiple R at each step. * = P<0.01, ** = P<0.001

	Triatoma rubida 1972		*Triatoma rubida* 1973		*Triatoma recurva* 1973	
Physical Factor (s) most highly correlated with number of bugs and R value	Temperature 0.387 **		Temperature 0.362 **		Relative Humidity -0.171 * Wind Speed 0.168 *	
Physical Factors correlated	Temp. and R.H.	-0.582	Temp. and R.H.	-0.494	Temp. and R.H.	-0.494
	Temp. and Wind	0.254	Cloud and R. H.	0.446	Cloud and R.H.	0.446
	R.H. and Cloud	0.228	Temp. and Wind	0.414	Temp. and Wind	0.414
First Variable entered and multiple R	Temperature 0.387 **		Temperature 0.362 **		R. H. 0.171*	
Second Variable entered	Wind 0.432		Wind 0.54		Wind 0.2095	
Third Variable entered	Moon 0.439		Cloud 0.55		Moon 0.2105	

Table 12. Mark-release-recapture study of *Triatoma rubida uhleri* in 1972.

Release Site	Number of Bugs Released	Number of Returns	Percent Returns
Km. 0.4	49	1	2.0
Mesquite	29	3	10.3
Road Y	57	7	12.6
One Way	65	3	4.6
Breakfast	69	8	11.6
Down	69	8	11.6
Misc.	33	4	12.1
Totals	371	34	–
Mean	–	–	9.06

Table 13. Mark-release-recapture study of Triatoma recurva and T. rubida uhleri in 1973.

Release Site	T. rubida Number of Bugs Released	T. rubida Number of Returns	T. rubida Percent Returns	T. recurva Number of Bugs Released	T. recurva Number of Returns	T. recurva Percent Returns
Km. 0.8	87	0	0	30	0	0
Flood Gate	38	4	10.5	21	2	9.5
Km. 1.6	12	0	0	11	0	0
River Trail	115	2	1.7	44	1	2.3
Pump House Trail	63	1	1.6	22	0	0
Lower Sabino Trail	7	0	0	0	0	0
Totals and	322	7	-	128	3	-
Mean	-	-	2.2	-	-	2.3

Table 14. Triatoma protracta collections from Neotoma albigula lodges near Sabino Canyon, Arizona. Percent of total in parenthesis.

Season	Adults	5th Instars	1st to 4th Instars	Total
Summer	6(35.3)	3(17.6)	8(47.1)	17
Fall	10(55.1)	5(27.8)	3(16.7)	18
Winter	9(56.3)	7(43.7)	0(0)	16
Spring	19(76.0)	5(20.0)	1(4.0)	25

Table 15. Number of *Triatoma rubida* obtained from *Neotoma albigula* near Sabino Canyon, Arizona, by month from July 1972 to August 1973. Percent of total in parenthesis.

Month	Number of Lodges Examined	Adults	5th Instars	1st to 4th Instars	Total
Jul. 1972	6	0	1(3)	32(97.0)	33
Aug. 1972	2	0	11(13.5)	69(86.5)	80
Sep. 1972	5	0	62(47.7)	68(52.3)	130
Oct. 1972	3	0	55(88.8)	7(11.2)	62
Nov. 1972	6	0	46(94.0)	3(6.0)	49
Dec. 1972	6	0	57(90.5)	9(9.5)	63
Feb. 1973	4	0	21(84.0)	4(16.0)	25
Mar. 1973	6	0	86(92.5)	7(7.5)	93
Apr. 1973	11	0	74(72.5)	28(27.5)	102
May 1973	13	19(19.0)	68(68.0)	13(13.0)	100
Jun. 1973	8	3(21.4)	6(42.9)	5(35.7)	14
Jul. 1973	8	5(12.8)	3(7.7)	31(79.5)	39
Aug. 1973	1	1(1.4)	4(5.6)	66(93.0)	71

Table 16. Sabino Canyon 30-year mean Centigrade temperature compared to 1973 mean temperature.

Month	30-year Mean Temperature	1973 Mean Temperature	Departure from Normal
Jan.	11.0	9.4	-1.6
Feb.	13.0	12.3	-0.7
Mar.	14.7	11.3	-3.4
Apr.	19.0	16.7	-2.3
May	23.6	23.9	+0.3
Jun.	28.4	28.4	0.0
Jul.	30.8	29.5	-1.3
Aug.	29.4	29.6	+0.2
Sep.	27.5	26.8	-0.7
Oct.	21.8	22.2	+0.4
Nov.	15.4	15.3	-0.1
Dec.	11.7	12.0	+0.3

Table 17. Histories of Triatoma rubida collected in instars other than 5th instar.

Number	Collection Date	Instar Collected	Date emerged to: 4th	5th	Adult	Sex	Reared in Incubator
1012	30 Aug. 72	4th	-	13 Oct. 72	23 May 73	F	No
1013	30 Aug. 72	4th	-	19 Sep. 72	26 Jun. 73	?	No
1069	10 Sep. 72	4th	-	15 Sep. 72	24 May 73	F	No
1070	10 Sep. 72	4th	-	15 Sep. 72	26 May 73	?	No
1274	5 Feb. 73	4th	-	9 Mar. 73	28 May 73	M	Yes
1412	18 Dec. 72	3rd	9 Mar. 73	9 Apr. 73	28 May 73	M	Yes
1444	23 Apr. 73	4th	-	20 May 73	10 Jun. 73	M	No
1457	23 Apr. 73	4th	-	20 May 73	17 Jun. 73	F	No
1458	23 Apr. 73	4th	-	20 May 73	14 Jun. 73	M	No
1462	18 Dec. 72	3rd	8 Apr. 73	21 May 73	18 Jun. 73	M	Yes
1465	11 Apr. 73	4th	-	22 May 73	21 Jun. 73	M	No
1466	8 Apr. 73	4th	-	24 May 73	20 Jun. 73	F	No
1468	15 Apr. 73	4th	-	20 May 73	19 Jun. 73	M	No
1469	2 May 73	4th	-	29 May 73	25 Jun. 73	M	No
1474	16 Apr. 73	4th	-	24 May 73	25 Jun. 73	F	No
1478	6 May 73	4th	-	22 May 73	25 Jun. 73	F	No
1479	18 Apr. 73	4th	-	14 May 73	29 Jun. 73	F	No
1480	17 Dec. 72	4th	-	29 May 73	1 Jul. 73	F	No
1481	23 Apr. 73	4th	-	5 Jun. 73	1 Jul. 73	F	No
1482	2 May 73	3rd	22 May 73	5 Jun. 73	9 Jul. 73	F	No
1486	16 Apr. 73	4th	-	24 May 73	23 Jul. 73	?	No
1489	21 Nov. 72	4th	-	29 Nov. 72	30 May 73	M	Yes
1490	5 Feb. 73	3rd	12 Mar. 73	28 Mar. 73	Died as 5th	?	Yes
1491	18 Apr. 73	3rd	27 May 73	28 Jun. 73	Died as 5th	?	No
1492	5 Feb. 73	3rd	27 Feb. 73	Died as 4th	-	?	Yes
1497	15 Jun 73	4th	-	23 Jul. 73	Late Aug.	?	No

Table 18. Starving rate of fed-starved *Triatoma rubida*. Fed once and then starved.

	Number	Mean Fed Weight	Mean Dead Weight	Mean Weight Loss	Mean Life Span	Percent Weight Lost	Percent Lost Per Day	Mean Days to Flight Weight
Females	23	189.2 ± 7.2*	66.0 ± 2.1	123.2	19.4 ± 0.6	65.1	3.35	15.6 ± 0.9
Males	22	111.9 ± 3.5	44.5 ± 2.3	67.38	19.9 ± 0.9	60.2	3.0	15.5 ± 0.9

* Standard error of the mean.

Table 19. Flight-starved Triatoma rubida, showing predicted (95 percent confidence interval) and actual life span after collection.

Number Males	Collection Date	Predicted Life Span 95% C. I.	Life Span Days	Collection Weight (mg.)
1697	10 Jun.	0- 3.3	4	46.0
1823	26 Jun.	0-10.4	2	58.4
1835	27 Jun.	1.8-19.6	1.5	76.0
1860	28 Jun.	0-11.8	4	59.7
1883	3 Jul.	0- 7.2	2.5	53.3
1884	3 Jul.	0- 4.7	2	50.0
1894	3 Jul.	0- 1.5	2	41.0
1897	3 Jul.	0- 2.2	2	43.3
1921	3 Jul.	0- 4.0	2.5	48.4
2014	5 Jul.	0-11.8	3	60.5
2015	5 Jul.	0.9-18.1	4	71.6
2019	5 Jul.	0- 5.5	4	51.5
2023	5 Jul.	0-11.8	3	60.5
2025	5 Jul.	0-12.5	4	61.3
Mean	-	-	2.9±0.25*	-

* Standard error of the mean.

Table 19. Continued

Number Females	Collection Date	Predicted Life Span 95% C. I.	Life Span Days	Collection Weight (mg.)
1689	10 Jun.	0- 1.6	2	57.5
1709	20 Jun.	0- 4.5	2	70.6
1811	24 Jun.	1-11.5	2	95.3
1813	24 Jun.	0- 2.0	2	60.8
1827	27 Jun.	7.7-21.3	5	152.5
1887	3 Jul.	0- 8.5	2	82.1
2006	3 Jul.	0- 9.7	2	85.8
2012	3 Jul.	1-11.7	2	96.4
2075	23 Jul.	0- 4.0	2	68.7
2089	25 Jul.	0- 6.5	5	75.5
2127	30 Jul.	0- 6.6	2	76.0
Mean	-	-	2.5 ± 0.37*	-

Table 20. Comparison of marked and unmarked Triatoma rubida uhleri.

	Marked		Unmarked	
	Male	Female	Male	Female
Mean life span (days)	27.7 ± 5.6*	37.8 ± 9.2	67.4 ± 11.8	43.1 ± 7.1
Eggs per female		28.4		52.7
Percent of eggs fertile		35.2%		77.4%

* Standard error of the mean.

Table 21. Eggs laid by 23 Triatoma rubida females collected at lights. These bugs were not exposed to males after capture, fed weekly until death.

Number	Collection Date	Total Eggs	Number Fertile (%)	Not Fertile	Life Span Days
1718	24 Jun.	12	11(91.6)	1	28
1851	28 Jun.	7	7(100)	0	11
1857	28 Jun.				11
1871	1 Jul.	1	1(100)	0	15
1877	1 Jul.	1	0	1	15
1898	3 Jul.	2	1(50)	1	14
1911	3 Jul.	12	12(100)	0	14
2003	3 Jul.	9	9(100)	0	19
2011	3 Jul.	6	3(50)	3	21
2020	5 Jul.	3	2(67)	1	13
2029	9 Jul.	38	15(39.5)	23	16
2041	9 Jul.				16
2046	10 Jul.	20	18(90)	2	30
2050	10 Jul.	10	10(100)	0	20
2051	12 Jul.	18	17(94.4)	1	28
2063	18 Jul.	13	11(84.6)	2	7
2069	18 Jul.				7
2072	22 Jul.	10	9(90)	1	10

Table 21. Continued

Number	Collection Date	Total Eggs	Number Fertile (%)	Not Fertile	Life Span Days
2077	23 Jul.	13	11(84.6)	2	-
2088	25 Jul.	11	8(72.7)	3	-
2104	29 Jul.	3	1(33)	2	9
2207	1 Aug.	13	4(30.8)	9	-
2224	4 Aug.	1	0	1	-
Totals		203	150	53	
Means		8.8 ± 1.3 per female	(73.9)	(26.1)	16 ± 1.6

Table 22. Eggs laid by reared females of Triatoma rubida uhleri.. These bugs were fed once on Neotoma albigula and kept continuously with males in a Neotoma lodge until death.

Number	Total Eggs	Number Fertile	Number Not Fertile	Life Span Days
1050	46	39	7	29
1073 1404	76	75	1	? 25
1209	37	36	1	29
1217 1415	43	40	3	24 30
1222	50	45	5	21
1242	27	27	0	23
1250	16	1	15	25
1258	39	39	0	22
1264	39	0	39	25
1268	9	0	9	31
1279 1317	31	23	8	22 21
1308	23	23	0	25
1313	24	1	23	19
1321	16	16	0	20
1322	22	22	0	23

Table 22. Continued

Number	Total Eggs	Number Fertile	Number Not Fertile	Life Span Days
1409	17	15	2	22
1419	13	11	2	25
1428	10	6	4	23
1454	26	16	10	21
Totals	564	435	129	-
Means	$25.6 \pm 2.55^{*}$ per female	(77.1%)	(22.9)	24 ± 0.73

* Standard error of the mean.

Table 23. Eggs laid by reared females of *Triatoma rubida uhleri*. These bugs were kept with males, fed weekly and reared in a *Neotoma* lodge until death.

Number	Total Eggs	Number Fertile	Number Not Fertile	Life Span Days
1014	112	87	25	75
1245 } 1315 }	109	78	31	68 65
1251	141	126	15	46
1263	67	54	13	57
1320	62	61	1	44
1324	58	22	36	61
1486	1	1	0	17
Totals	550	429	121	-
Means	68.75 ± 14.8* per female	78%	22%	54.1 ± 6.5

* Standard error of the mean.

Table 24. Twenty-one females of Triatoma rubida laid no eggs after collection at lights. Fed weekly until death.

Number	Collection Date	Life Span Days	Collection Weight (mg.)
1858	28 Jun.	12	87.0
1862	28 Jun.	12	71.1
1868	1 Jul.	9	74.2
1896	3 Jul.	20	69.8
1912	3 Jul.	6	78.0
2027	9 Jul.	8	68.8
2043	10 Jul.	13	75.0
2057	16 Jul.	7	77.7
2061	17 Jul.	13	72.6
2071	18 Jul.	12	76.1
2074	23 Jul.	7	70.0
2080	23 Jul.	7	116.9
2082	23 Jul.	3	74.3
2090	25 Jul.	5	75.9
2096	25 Jul.	8	151.0
2109	29 Jul.	9	85.1
2114	30 Jul.	10	68.5
2119	30 Jul.	10	91.3

Table 24. Continued

Number	Collection Date	Life Span Days	Collection Weight (mg.)
2124	30 Jul.	10	88.5
2213	1 Aug.	8	85.0
2215	1 Aug.	8	86.7
Means		9.38 ± 0.78*	83.0 ± 4.2

* Standard error of the mean.

LOMA LINDA UNIVERSITY

Graduate School

NOCTURNAL FLIGHTS OF TRIATOMA (HEMIPTERA:REDUVIIDAE)

IN SABINO CANYON, ARIZONA

by

David B. Ekkens

An Abstract of

a Dissertation in Partial Fulfillment

of the Requirements for the Degree Doctor of Philosophy

in the Field of Biology

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ABSTRACT

Three species of Triatoma were studied in this investigation: T. rubida uhleri (Neiva), T. protracta protracta (Uhler), and T. recurva (Stal) (Hemiptera:Reduviidae). These blood-sucking bugs are ectoparasites of vertebrate animals. Triatoma rubida uhleri (Neiva) is the most common conenose bug in southern Arizona.

At certain seasons of the year Triatoma bugs enter homes and bite people causing an allergic reaction in sensitized individuals. The purpose of this study was to determine cause of flight, time of day and season of the year most individuals fly, effects of various physical factors on flights and distances flown.

This research was conducted at lights in Sabino Canyon, northeast of Tucson, Arizona. A black light was operated 4 to 6 nights per week during the summers of 1972 and 1973. For each Triatoma bug collected physical conditions (temperature, relative humidity, cloud cover, moonlight, wind speed and direction) and time of arrival were noted.

Computer analysis of the data was performed using programs written in FORTRAN IV and a prepared program (BMD 02R) from UCLA Health Sciences Computing Facility.

Lodges of Neotoma albigula Hartley, the natural host of Triatoma rubida and T. protracta protracta, were examined for the presence of bugs during all seasons of the year. Seventy-nine lodges were examined.

A total of 1107 Triatominae were collected at lights and traps and 941 from *Neotoma* lodges. Twelve species of reduviids other than Triatominae were also collected at the black lights. Three species of buprestids were collected on sticky traps. Desert tortoises, banded geckos and scorpions were found in *Neotoma* lodges.

Triatoma rubida uhleri bugs overwinter as 5th instar nymphs. As soon as average temperatures warm up to 23^{o} to $25^{o}C$, the 5th instar nymphs begin molting to adults. This produces large numbers of adult bugs in early summer. *T. rubida* has a short adult life span; by fall very few adult bugs are left alive.

Triatoma flights appear to be due to starvation. If adult bugs find themselves without a wood rat host, they become starved within approximately 15 days following their last blood meal. Because the *Neotoma* move about from lodge to lodge, and furthermore because of predation on them by owls, snakes, and bobcats, the *Triatoma* may be without hosts for extended periods of time. With very few exceptions, bugs arrive at the light in a starved condition and die within a few days, if not fed.

Time of day (or amount of light) is a limiting factor in bug flights. The vast majority of Triatominae bugs in this study were collected in the first 4 hours after dark. Only 5 bugs were received before zero footcandles of light.

The most important physical factors promoting the flight of *T.*

rubida are high temperatures, low relative humidity and low wind speeds. For T. recurva the factors promoting flights are temperatures in the range 22° to 35°C and low relative humidity.